PRICE $1.00

Assembling
and Using Your...

# Heathkit

## BROADCAST TUNER

MODEL BC-1

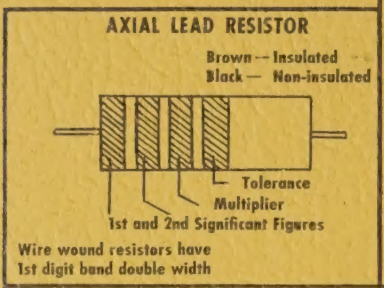
**HEATH COMPANY**

*A Subsidiary of Daystrom Inc*

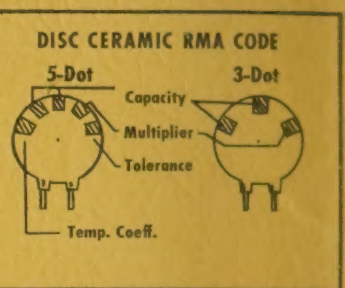
**BENTON HARBOR, MICHIGAN**

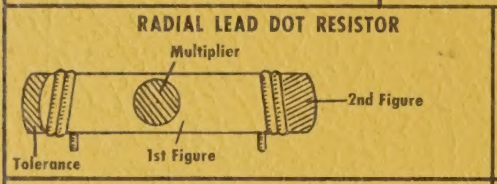
595-124

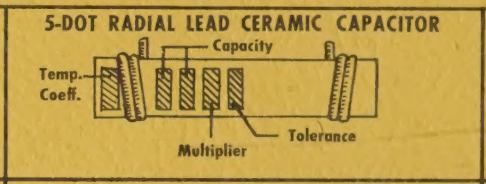
# STANDARD COLOR CODE — RESISTORS AND CAPACITORS

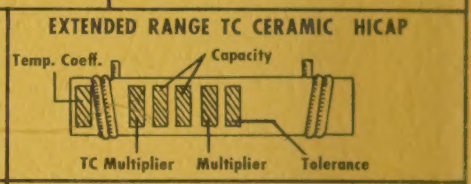


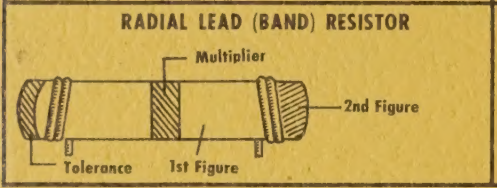

| INSULATED UNINSULATED Color | FIRST RING BODY COLOR First Figure | SECOND RING END COLOR Second Figure | THIRD RING DOT COLOR Multiplier |
|---|---|---|---|
| BLACK | 0 | 0 | None |
| BROWN | 1 | 1 | 0 |
| RED | 2 | 2 | 00 |
| ORANGE | 3 | 3 | ,000 |
| YELLOW | 4 | 4 | 0,000 |
| GREEN | 5 | 5 | 00,000 |
| BLUE | 6 | 6 | 000,000 |
| VIOLET | 7 | 7 | 0,000,000 |
| GRAY | 8 | 8 | 00,000,000 |
| WHITE | 9 | 9 | 000,000,000 |

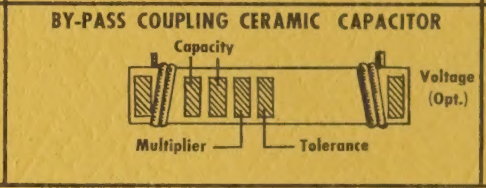


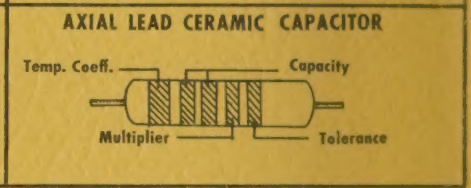



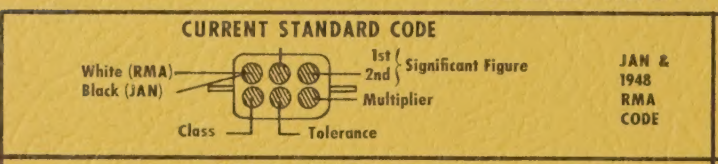



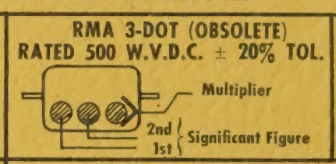



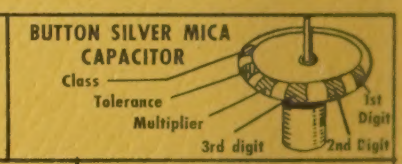

The standard color code provides all necessary information required to properly identify color coded resistors and capacitors. Refer to the color code for numerical values and the zeroes or multipliers assigned to the colors used. A fourth color band on resistors determines tolerance rating as follows: Gold = 5%, silver = 10%. Absence of the fourth band indicates a 20% tolerance rating.

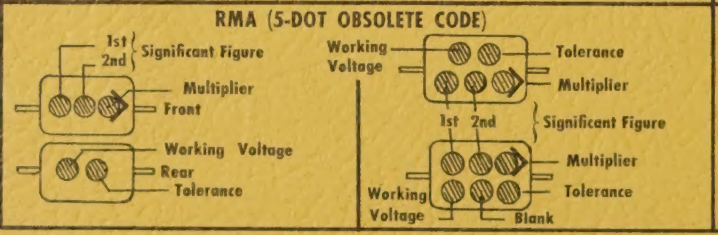
The physical size of carbon resistors is determined by their wattage rating. Carbon resistors most commonly used in Heathkits are ½ watt. Higher wattage rated resistors when specified are progressively larger in physical size. Small wire wound resistors ½ watt, 1 or 2 watt may be color coded but the first band will be double width.

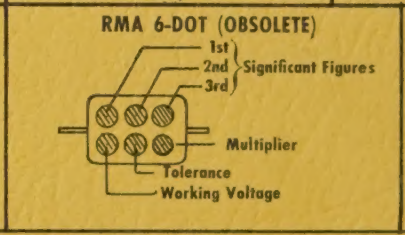
# MOLDED MICA TYPE CAPACITORS

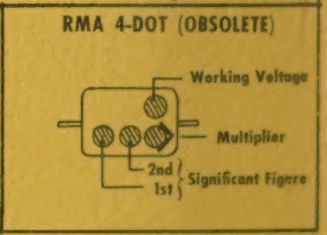


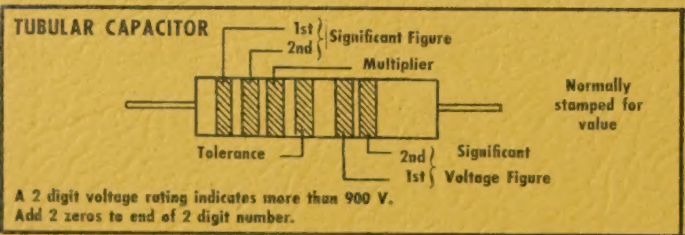



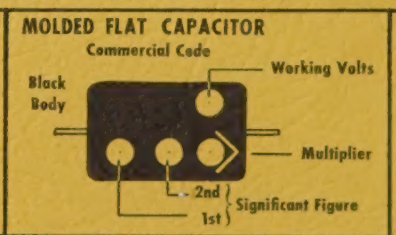



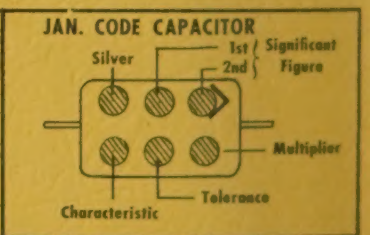




# MOLDED PAPER TYPE CAPACITORS



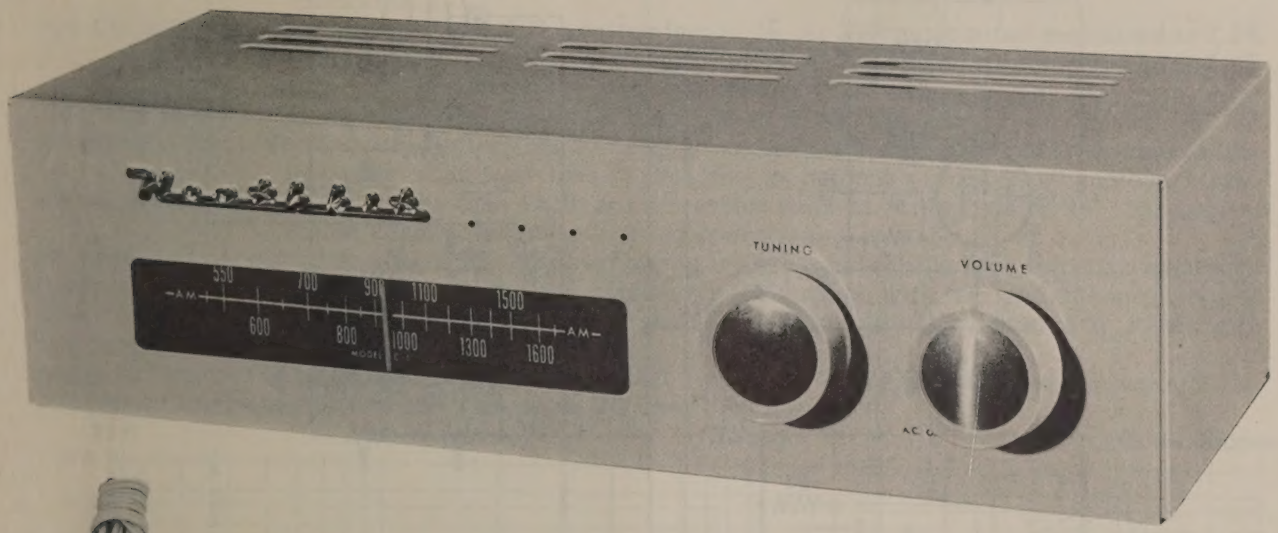

The tolerance rating of capacitors is determined by the color code. For example: red = 2%, green = 5%, etc. The voltage rating of capacitors is obtained by multiplying the color value by 100. For example: orange = 3 × 100 or 300 volts. Blue = 6 × 100 or 600 volts.

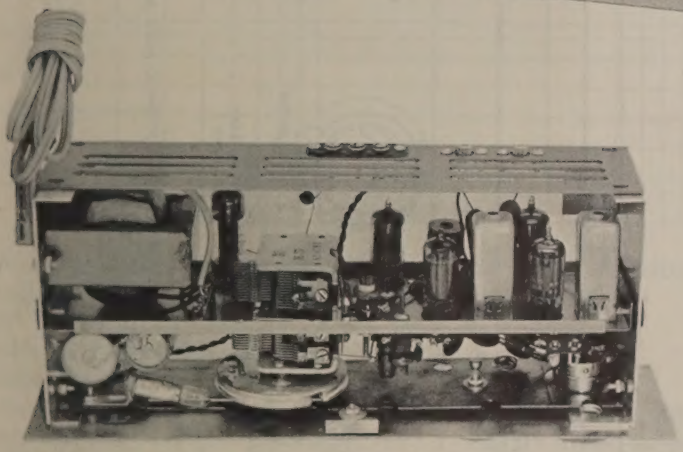
In the design of Heathkits, the temperature coefficient of ceramic or mica capacitors is not generally a critical factor and therefore Heathkit manuals avoid reference to temperature coefficient specifications.

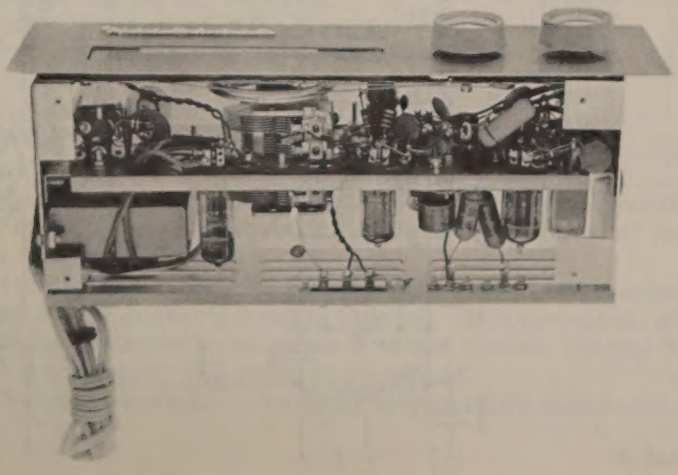
Courtesy of Centralab

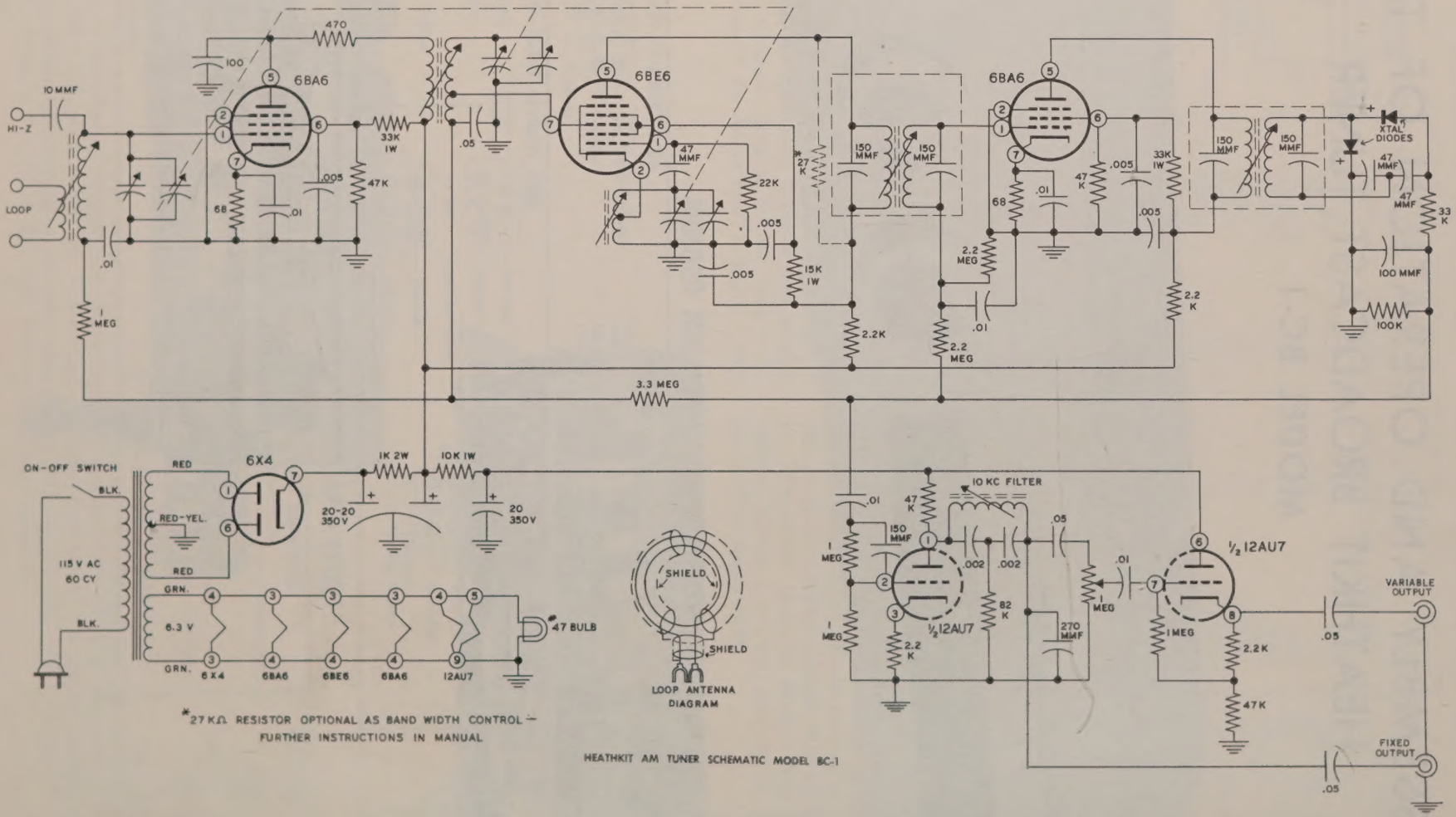
# ASSEMBLY AND OPERATION OF THE HEATHKIT BROADCAST TUNER

## MODEL BC-1





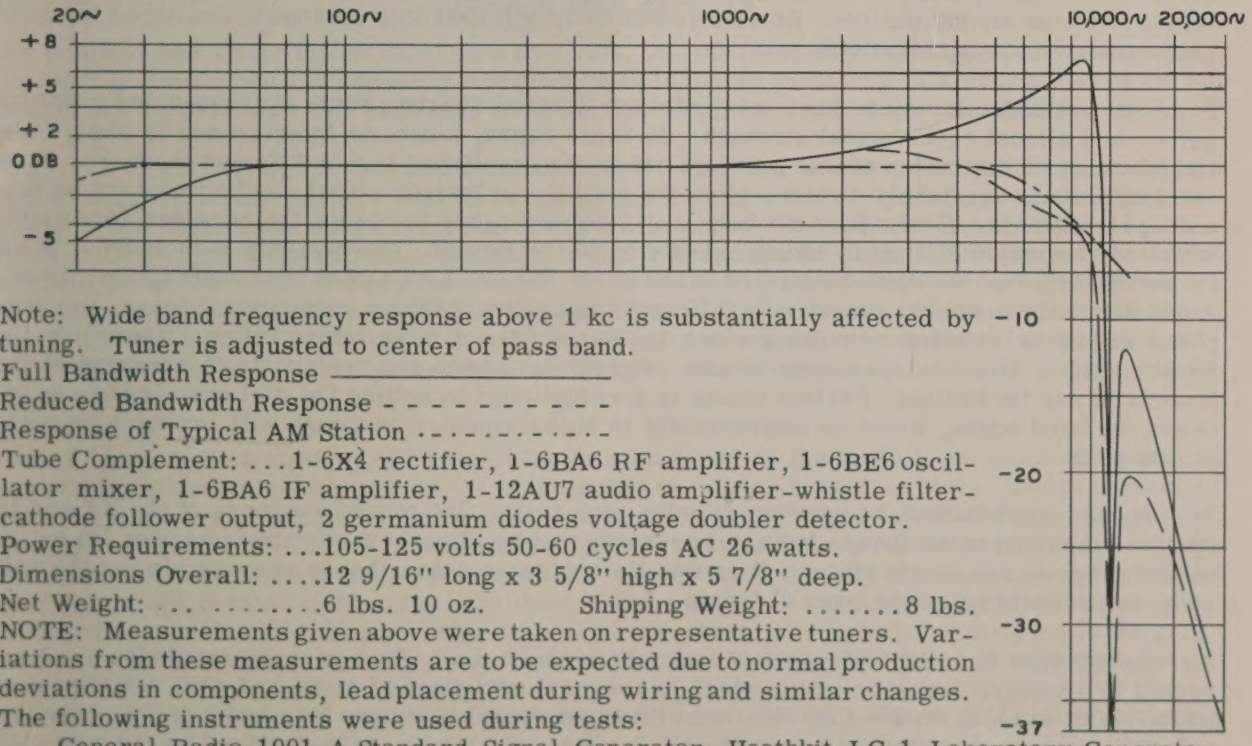



*27 KΩ RESISTOR OPTIONAL AS BAND WIDTH CONTROL — FURTHER INSTRUCTIONS IN MANUAL

HEATHKIT AM TUNER SCHEMATIC MODEL BC-1

# SPECIFICATIONS BC-1

Tuning Range: ....550-1600 kc.
IF Frequency: ....455 kc.
Antennae: ..... Low impedance electrostatically shielded loop or conventional straight wire.
Outputs:..... Two outputs are provided, one at medium impedance fixed level, the other at low impedance from a cathode follower with variable level controlled by the tuner volume control. Recommended load impedance 200 KΩ or higher shunted by .007 μfd or less. Up to 100 feet of shielded microphone cable or up to 200 feet of RG-58A/U coaxial cable may be used between the cathode follower output and the preamplifier with not more than 3 db loss at 10,000 cps.
Output Voltage: ...1 volt rms with 3 microvolts input up to 11 volts maximum with .1 volt input. (Level approximately the same at either output with volume control fully clockwise.)
400 Cycle Distortion (measured with 100 μvolts signal): ... At 30% modulation measured as 2.3% with 1.5% measured from the generator. At 70% modulation measured as 2.6% with 1.6% measured from the generator.
Hum and Noise: ...40 db below 100 μvolts 30% modulated at 400 cps.
Sensitivity For 1 Volt Output: Better than 3 μvolts across entire band measured from source impedances of 50 Ω or less. Little change evident with narrow band operation.
Signal to Noise Ratio: ... Better than 12 db across entire band at rated sensitivity. No appreciable change with narrow band operation.
No sensitivity or signal to noise ratio measurements are provided for the high impedance antenna input since the BC-1 tuner is designed for optimum performance with the loop antenna provided with the kit. Sensitivity will be less and the signal-to-noise ratio is substantially lower with this type of antenna.
Adjacent Channel Selectivity: ... 27 db with broad response, 29 db narrow band response. *
Frequency Response (at end of 6' length of RG 58A/U cable):




Note: Wide band frequency response above 1 kc is substantially affected by tuning. Tuner is adjusted to center of pass band.
Full Bandwidth Response ————————
Reduced Bandwidth Response - - - - - - - - - -
Response of Typical AM Station · · · · · · · · · ·
Tube Complement: ...1-6X4 rectifier, 1-6BA6 RF amplifier, 1-6BE6 oscillator mixer, 1-6BA6 IF amplifier, 1-12AU7 audio amplifier-whistle filter-cathode follower output, 2 germanium diodes voltage doubler detector.
Power Requirements: ...105-125 volts 50-60 cycles AC 26 watts.
Dimensions Overall: ....12 9/16" long x 3 5/8" high x 5 7/8" deep.
Net Weight: ..... .6 lbs. 10 oz. Shipping Weight: ..... 8 lbs.
NOTE: Measurements given above were taken on representative tuners. Variations from these measurements are to be expected due to normal production deviations in components, lead placement during wiring and similar changes.
The following instruments were used during tests:
General Radio 1001-A Standard Signal Generator, Heathkit LG-1 Laboratory Generator, Heathkit AG-9 Audio Generator, Heathkit HD-1 Harmonic Distortion Meter, General Radio 1000-P3 50 Ω to 1 Ω voltage divider adaptor.
CONDITIONS: 1001-A signal generator terminated with 1000-P3 voltage divider to approximate input impedance at the loop antenna input, direct connection made to input. Measurements made at 100 μvolts input at 1000 kc and across the variable level output with the volume control fully clockwise unless otherwise specified. Line voltage, 117 volts 60 cycles AC.
*Selectivity measurements made with two signal generators tuned 10 kc apart 30% modulated 400 cycles 100 μvolts each.

## FEATURES

Most commercial AM tuners conform to a definite circuit configuration and general performance figures are much the same for all of them. In most cases, engineering has been toward high sensitivity and selectivity but with standard bandwidth, which is rather narrow, limiting response from the tuner to 5 kc or less. In many cases, this is sufficient, since many broadcasting stations limit their transmitted response to 5 kc. A large number of stations have flat response to 10 kc however, and it is impossible for one of the standard tuners to take advantage of the wider range transmission. In rare cases, full bandwidth AM to 15 kc will be found and the program material in this case can almost be considered "hi-fi" except for the necessarily limited dynamic range. Obviously, almost all of this type of signal would be lost in a conventional tuner and the station would sound the same as one with 5 kc limited response.

The Heathkit AM Tuner model BC-1 is capable of flat response up to 9 kc and with wide range program sources, the effect is quite similar to FM. In many instances, "A-B" comparisons between AM and FM sister stations can be made with little or no apparent difference, proving that material above 10 kc is not very common. A little high frequency pre-emphasis is employed in the BC-1 to provide additional "brilliance" to the higher frequency sounds, thus giving the illusion of greater range than actually present.

Design of the BC-1 AM Tuner is toward optimum performance when tuned to strong signals from local stations and powerful "clear channel" stations located within a reasonable distance. Weak and crowded signals are useless for a high fidelity installation since the programming cannot be enjoyed for long due to the noise and splatter from adjacent stations. Therefore, sensitivity is not intended to be a feature of the BC-1 although it is relatively high. Careful attention has been given to selectivity and 10 kc interstation whistle rejection so that maximum benefit can be obtained from the strong stations. An electrostatically shielded loop antenna is employed for quiet performance in noisy locations.

Some metropolitan locations have many stations located nearby, some at frequencies close together and almost equal signal strength. In these cases, sideband interference is likely to be troublesome. Elimination of this problem can be accomplished in two different manners. Since the loop antenna is sharply directional on the null, the undesired signal can be tuned out by orienting the antenna. If this does not help it will be necessary to reduce the receiver bandwidth, which can be accomplished by adding a resistor to the circuit. The resistor is included with the kit and installation instructions will be found under INSTALLATION in the construction manual. A wideband AM tuner has an entirely different tuning "feel" than a conventional tuner, the response and noise quieting remaining much the same over a wide tuning range. Therefore the Heathkit BC-1 Tuner is very easy to tune, a great help when the "uninitiated" members of the household use the system. Perfect tuning is accomplished by setting the dial exactly midway between the band edges, since an improvement in high frequency response will probably be noted at this point.

Tuning indicators cannot be used practically, due to the flat-topped response of the RF and IF system employed in the tuner. Indicator response will be almost exactly the same over the entire tuning range on any single station. It is this flat response curve that is responsible for the wide range reproduction and the ease of tuning.

An unusual type of detector is used to improve performance. Two germanium diodes are connected in a voltage doubler circuit, which has several advantages. Audio and AVC voltage output from this detector is double that obtained with conventional types, so less audio gain is required and AVC action is substantially improved. Symmetrical loading is maintained on the output IF transformer, reducing distortion and improving performance on modulation peaks.

In order to reduce 10 kc whistle caused by beats between the carrier tuned and one on an adjacent channel, a bridged-T filter is used. A very sharp rejection notch can be obtained with this type of filter allowing the undesired frequency to be rejected without materially affecting frequency response at other points. Output from this filter is taken out to a fixed level output at medium impedance and from a cathode follower at variable level for installation requiring remote location of the tuner.

## INTRODUCTION

Although low in price, the Heathkit AM Tuner model BC-1 is soundly engineered and is capable of stable and unusually wide band performance. Careful layout and circuit design, as well as specially selected components contribute to this result.

Two outputs are provided, one at fixed level which is not affected by the volume control on the tuner and the other at the same maximum level which is controllable. Thus the tuner can be used with high fidelity systems which have a level set control on the input, such as the Heathkit Preamplifier model WA-P2 or with any amplifier by using the high level controllable output.

Good performance can be obtained by connecting the variable output to transformer-operated portable phonograph players which have an extra input connection provided or TV sets which have phono inputs. Practically any transformer-operated TV set can be modified for use as an amplifier and any competent serviceman can make this addition at a nominal charge. The tuner must NOT be operated with AC-DC equipment. See Instructions under INSTALLATION in the back of the manual.

For best performance, the tuner should be used with a high fidelity type of system, since it is only with a wide range system that the full benefit of a wide band AM can be realized. The advantages of wide band, low distortion AM over conventional AM receivers will be readily apparent with any type of amplifier however. Use of the BC-1 AM Tuner will provide performance quite comparable with FM as long as the station tuned has reasonable signal strength and audio quality.

## CIRCUIT DESCRIPTION

The Heathkit AM Tuner model BC-1 is a five tube, AC operated superheterodyne receiver employing high gain tubes and carefully designed coils in all RF circuitry. Careful layout of components and leads allows this high gain to be realized without troublesome instability.

Two types of antenna inputs are used for installation flexibility. A low impedance, two-turn loop may be used (furnished with the kit) which provides very high sensitivity with good noise immunity and broad directional characteristics. Very low impedance circuits are not sensitive to electrostatic noise, but allow efficient transfer of electromagnetic RF signals. Proper impedance matching to the RF amplifier grid is obtained by use of an extremely large secondary to primary winding ratio. An electrostatic type of antenna input is also provided, which couples the high impedance straight wire type of antenna to the RF amplifier grid circuit directly through a 10 $\mu\mu$f capacitor. A much smaller antenna can be used where necessary, but with poorer noise rejection.

A 6BA6 tuned radio frequency (RF) amplifier is used ahead of the tuner to increase the overall gain and to reduce coupling between the antenna and oscillator-mixer circuits. Signal is picked up by the antenna and is coupled to the antenna coil through either the low or the high impedance windings. This coil is tuned to give maximum gain at the desired signal frequency and to eliminate all other signals as much as possible. RF energy from the coil is coupled directly to the control grid of the 6BA6 tube and is amplified. Output signal is taken from the plate of the tube to the primary winding of the interstage or mixer coil, where it is inductively coupled to the grid circuit of the 6BE6 mixer and tuned once again to further increase the gain and selectivity.

Inspection of the schematic will reveal that the 6BE6 tube has five grids, a plate and a cathode from which the name "heptode" converter is derived. The first and second grids with the cathode comprise a triode, which is employed as a Hartley oscillator in the BC-1 Tuner. A tuned circuit is connected between the first grid and ground, with the cathode connected to a tap on the coil near the ground end, thus providing feedback to maintain oscillation. High voltage (B+) is connected to the #2 and #4 grids which are tied together internally in the tube. The #2 grid becomes a plate for the triode section and the #4 grid a screen grid for the pentode section, containing the cathode, the #3 control grid, the #5 suppressor grid and the anode, or plate.

Signal from the RF stage is amplified once again at the 6BE6 mixer stage, along with another signal coming from the oscillator contained in this same stage. Since the oscillator and RF signals are both present in the tube, they mix in such a manner that the sum and difference of the two frequencies are present at the output of the mixer, as well as the RF and oscillator signal. The oscillator frequency is selected so it is always 455 kilocycles (kc) higher than the tuned frequency of the RF section. Therefore, the difference will always be 455 kc. It is to this frequency that the intermediate frequency (IF) transformers are tuned. This function of changing frequencies is known as the Superheterodyne Principle. Improved selectivity and gain is obtained due to the fixed tuned IF transformers, which are designed to provide optimum performance at one frequency only.

RF energy from the plate of the mixer is coupled through the first IF transformer to the grid of the 6BA6 RF amplifier, where the 455 kc difference or intermediate frequency is amplified. The first IF transformer will pass the 455 kc signal and reject almost all others. Boosted IF signal is taken from the plate of the 6BA6 to the second IF transformer, where residual signals are reduced even further.

Amplitude Modulation (AM) consists of a carrier frequency which is heterodyned or mixed with the audio modulating frequency at the transmitter, producing four frequencies of which three are transmitted. Exactly the same thing occurs at the transmitter that takes place in the 6BE6 mixer in that the carrier frequency will be present along with the sum and difference of the carrier and audio, called "sidebands." None of the audio is transmitted. Sideband distance on each side of the carrier frequency is determined by the audio frequency, higher modulating frequencies spreading the sidebands farther apart. Sideband power is determined by the percentage of modulation, with 50% of additional power present in the sidebands at 100% modulation, the fundamental power remaining exactly the same as with no modulation. The additional 50% sideband power is furnished by the transmitter modulator. Since sideband power and amplitude varies with modulation percentage, the term "Amplitude Modulation" is applied.

Although AM could conceivably be of high fidelity character, it normally is not for two main reasons. Broadcast frequency allocations are 10 kc apart and sidebands from each station must be limited to 5 kc on each side of the carrier in order to prevent interference with the next channel, unless the station has relatively clear channels on each side, or employs a protective field pattern to prevent interference. Therefore, 5 kc is the maximum audio high frequency response permitted when adjacent station channels must be protected. Radio stations with a severe protection problem will cut audio response above 5 kc off very sharply. Others may have relatively clear space and will transmit audio up to 10 kc, although the response may be rolled off somewhat above 5 kc. A few AM stations such as WQXR in New York have frequency allocations and field patterns such that it is not necessary to protect other stations and as a result, transmit the full 15 kc audio bandwidth. The other reason for poor hi-fi performance from AM is that the dynamic range is limited. Over 100% modulation will clip audio peaks, causing distortion and signal splatter into adjacent channels. A limiter to compress louder peaks must therefore be used, with a resultant loss of dynamic range.

Detection of AM signals is accomplished in much the same manner in all AM receivers. One half of the modulated carrier envelope is removed by rectifying the carrier in some manner, usually by employing a non-linear unidirectional current device such as a vacuum tube or crystal diode. Crystal (germanium) diodes are used in the BC-1 tuner. RF energy remaining after detection is removed in a low pass filter which shorts out high frequency energy, but passes audio with very little loss.

An unconventional type of detector is used in the BC-1 AM Tuner, although the basic principle of operation is much the same as the more conventional single diode type of detector used in the majority of sets on the market today. Two diodes are employed in a voltage doubler circuit connected to the secondary of the second IF transformer. One diode is connected between the IF transformer and ground and this one serves the normal function of rectifying or detecting one peak of the IF signal, storing the developed negative DC voltage across a 47 $\mu\mu$f capacitor which is also connected between the IF transformer and ground. This diode conducts during the positive portion of the IF signal which is high frequency AC (alternating current).

Since the positive portion of the signal is shorted to ground through the diode, only the negative portion will be available to charge the condenser, the diode appearing as an open circuit to a negative potential. When a negative swing takes place, the remaining diode connected between the IF transformer and the filter will conduct, allowing the negative voltage to appear at the filter input. Both diodes develop a negative voltage and these voltages add to each other to give twice the DC potential that would be provided by a single diode type of detector, as well as twice the demodulated audio voltage. Symmetrical loading is maintained on the IF amplifier, for conduction occurs on both peaks of the IF carrier, thus reducing non-linearity and resultant audio distortion. Another advantage is gained in that the IF ripple frequency is doubled from 455 kc to 910 kc allowing more effective filtering of IF signal, with less high frequency audio loss.

Most of the residual IF energy remaining after detection is bypassed to ground through the series combination of two 47 $\mu\mu$f capacitors connected between the 33 K$\Omega$ resistor and ground. Detected audio and the remaining IF energy is passed through the 33 K$\Omega$ resistor where the rest of the IF ripple is bypassed to ground through a 100 $\mu\mu$f capacitor. Values of resistance and capacity in this circuit are carefully chosen to provide maximum attenuation of high frequency AC (RF and IF) while passing audio up to 10 kc with practically no loss.

Audio from the detector circuit is coupled from the filter output through a .01 $\mu$fd capacitor to a network of two 1 megohm resistors and a 150 $\mu\mu$f capacitor. These resistors are arranged so that only one half of the audio voltage is applied to the grid of the 12AU7 tube at audio frequencies of 1 kc and lower. At higher frequencies, the 150 $\mu\mu$f capacitor begins to bypass some of the audio signal around the attenuating resistor, causing a gradual rise in audio output from 1 kc up to 10 kc to compensate for broadcast station rolloff at high audio frequencies. The first half of the 12AU7 is a conventional triode amplifier and boosts the compensated signal applied to the grid to approximately ten times the input amount. Output from the plate is connected to the 10 kc whistle filter, known as a "bridged T" filter. This circuit acts as an extremely high impedance or resistance to audio at its tuned frequency and thus refuses to pass this specific frequency. Other frequencies are passed with little attenuation and so only a sharp notch appears in the response.

Audio from the whistle filter is connected to the fixed tuner output through a .05 $\mu$fd capacitor and to a volume control through another condenser of the same value. A volume control is a fixed resistance with a sliding tap. By moving the position of the tap, it is possible to select any desired portion of the entire signal appearing across the fixed terminals of the control. The fixed amplitude signal is taken out of the fixed resistance terminals of the control and so the control has no effect on this output. Output from the variable tap is connected through a .01 $\mu$fd capacitor to the grid of the second half of the 12AU7 tube.

The second half of the 12AU7 is connected as a cathode follower to provide a low impedance output for long audio leads. A cathode follower is an impedance converting device, converting the high impedance input to a low impedance output with only a slight loss in audio voltage. Low impedance circuits are advantageous in that it becomes possible to run relatively long shielded leads between the tuner and the amplifier with very little high audio frequency loss and low hum pickup.

In order to avoid distortion, loss of gain and overload, it is necessary to "bias" the tubes in an RF or audio amplifier in some manner. This term refers to application of a negative potential on the grid of a tube in respect to the cathode. If the grid (the tube control element) is at the same potential as the cathode (the heated electron emitting element), an applied signal voltage will cause the grid to draw current since the grid and cathode form a rectifier, or diode, under these conditions. When grid current is drawn, the portion of the waveform involved is clipped off or distorted by the diode action. In most cases, this is very undesirable and bias is applied to the grid so that signal voltage can be varied without swinging the grid potential positive in respect to the cathode. A number of methods can be used to obtain a negative voltage on the grid, two different types being used in the BC-1. Cathode bias is employed for all tubes except the 6BE6, which uses AVC voltage discussed later. If a resistor is installed in the cathode circuit of a tube, current through the tube will cause the cathode to appear positive in respect to ground. Since the grid of the same tube is tied back to ground through a resistor or an IF transformer, the cathode will be positive in respect to the grid, which is the same as making the grid negative in respect to the cathode.

AVC (Automatic Volume Control) action is obtained by feeding the negative DC voltage developed at the voltage doubler detector back to the grid circuits of the 6BA6 RF amplifier, the 6BE6 mixer and the 6BA6 IF amplifier. A 3.3 megohm resistor and a .05 μfd capacitor comprise the filter needed to remove all audio from the AVC voltage, which is taken from the same point as the audio. DC output from this network is proportional to the incoming signal strength and so is useful as a gain controlling voltage. When the voltage or bias at the grid of a tube is increased in a negative direction, the gain will be reduced. Thus, the stronger the signal, the less sensitive the set becomes, which tends to keep the audio level relatively constant and prevents overloading when tuned to very strong signals. AVC is applied to the grid circuit of the 6BE6 from the 3.3 megohm resistor and .05 μfd capacitor through the grid coil, RF signal being referred to ground through the capacitor. AVC bias for the 6BA6 RF stage is taken from the same point but through another filter of 1 megohm and .01 μfd to provide isolation between the two stages. Again, the voltage is applied to the grid through the antenna coil, with signal return provided by the .01 μfd capacitor. Control voltage for the 6BA6 IF amplifier is reduced by using two 2.2 megohm resistors as a voltage divider and a .01 μfd capacitor as an audio filter and signal return for the first IF transformer. Reduced AVC is desirable in the IF amplifier to keep the stage operating in a more linear fashion, thus reducing distortion. Since the AVC voltage from the voltage doubler detector is approximately double that obtained with other types, overload is less likely to occur and audio output variation between weak and strong stations is kept at a miminum.

Wideband detection of AM transmission presents problems in tuner design not normally encountered. As mentioned previously, all of the modulation intelligence is contained in the sidebands which are removed from the carrier frequency at a distance determined by the modulating frequency, higher audio frequencies spreading the sidebands further apart. No information is contained on the carrier itself, so it becomes evident that the best possible audio frequency response available from a receiver depends entirely on its ability to pass the higher frequency sidebands without attenuation. Wide range frequency response in the detector is not difficult to obtain, although careful design and somewhat complex circuits are required to obtain this result with low distortion and good filtering of any radio frequency energy that is present. Filtering is necessary to keep the IF frequency from the audio amplifier, where it may cause audio distortion and re-radiation of the IF frequency which causes instability. Unfortunately, good IF filtering usually causes high frequency audio loss since attenuation of 455 kc must be high, but very low at audio frequencies up to 10 kc. This problem is lessened by use of the voltage doubler detector which also doubles the IF frequency, increasing the spread between the frequencies which must be passed and eliminated.

Any detector can function only as well as the signal applied to it. If sidebands are suppressed in the RF or IF system of a receiver, the resultant audio response will be suppressed in the same manner. The IF signal in a superheterodyne receiver is an exact duplicate of the incoming RF signal, the only change being the carrier frequency. Carrier and oscillator frequencies are removed at the first IF stage, only the difference frequency and the original sidebands being passed.

At this point, "bandwidth" becomes very important, for a narrow or sharply tuned IF transformer such as used in most commercial receivers will substantially attenuate the higher frequency sidebands, response usually being down about one-half at approximately 6 kc and some attenuation starting around 2 kc.

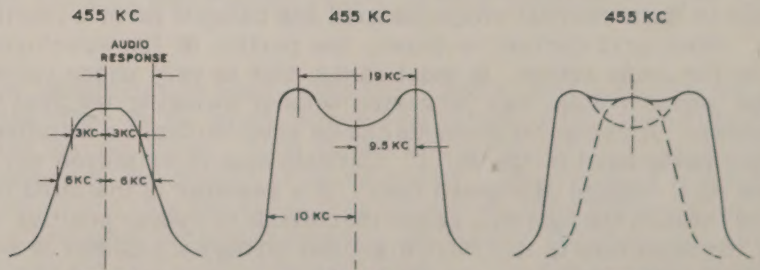



Figure A Figure B Figure C

Figure A on Page 8 illustrates a conventional IF response curve and shows sideband attenuation at several different frequencies. Audio response will be roughly equivalent to one half of the IF waveform without compensation. A wide band transformer is used at the input of the Heathkit BC-1 IF system which is an over-coupled type, providing a response as shown in Figure B. Total bandwidth is approximately 19 kc across the peaks. Obviously, the frequency response would be quite non-linear if this were the total IF response, with high frequencies being predominant. Therefore, the output IF is sharply peaked to appear approximately the same as in Figure A. The sharp peak fills the valley in the middle of the input transformer response and the result is shown in Figure C, where the response appears flat to about 9.5 kc on each side of the 455 kc center frequency. Use of an over-coupled transformer at the IF input is contrary to usual practice, but it allows the transformer to operate at high impedance, resulting in a very steep slope at each side of the IF curve. A steep slope is vital in wide band equipment, since it will give excellent attenuation of adjacent channel carriers 10 kc on each side of the station tuned, at the same time allowing very flat audio response up to 9 kc. A sharp reduction of sensitivity at 10 kc each side of the carrier frequency will also aid the whistle filter in its function. Bandwidth of the RF and mixer coils is such that it does not substantially alter the response of the IF system at any dial setting.

Sharp attenuation at 10 kc is required to reduce the audio heterodyne produced when the carriers of two adjacent stations beat with one another in the receiver. This whistle will be present in any radio or tuner, especially at the high end of the band and can become extremely annoying after listening to AM for a short time. It is for this reason that the IF response is cut off sharply at 10 kc each side of the IF frequency and the notch type whistle filter used.

Power for the receiver is obtained from the power supply, which involves the power transformer, the 6X4 tube and electrolytic filter capacitors. The transformer supplies filament voltage for all tubes and high AC voltage to the plates of the rectifier. The rectifier action is exactly the same as that taking place in the diode detector described above, the positive pulses being passed by the rectifier and the negative cut off. The output voltage is a series of positive pulses, one for each half of the 60 cycle line waveform. The voltage applied to the tubes must be free of these pulses, or ripple, or only a loud buzz will be evident from the speaker system. It is for this reason that the high capacity filter capacitor is used. The first section of the capacitor charges to the voltage from the 6X4 tube. When the tube is not conducting, the capacitor starts to discharge through the load presented by the other tubes in the receiver. However, the next positive charge takes place before the capacitor has time to discharge fully, so the voltage is smoothed out somewhat.

Final filtering action takes place in the second section of the filter capacitor. This section is isolated from the first by a 1000 Ω resistor which tends to help smooth the voltage because it resists current variations passed by the first part of the capacitor and the voltage output is "pure" direct current (DC).

A third filter is used between the power supply and the audio output stages to reduce hum to an absolute minimum and prevent interaction between the audio and RF stages.

## NOTES ON ASSEMBLY AND WIRING

The Heathkit AM Tuner model BC-1 when constructed in accordance with the instruction in this manual, is a high quality tuner capable of many years of trouble-free service. We urge you to take the necessary time to assemble and wire the kit carefully. Do not hurry the work and you will be rewarded with a greater sense of confidence, both in your tuner and your own ability.

This manual is supplied to assist you in every way to complete the instrument with the least possible chance for error. We suggest that you take a few minutes now and read the entire manual through before any work is started. This will enable you to proceed with the work much faster when construction is started. The large fold-in pictorials are handy to attach to the wall above your work space. Their use will greatly simplify completion of the kit. These diagrams are repeated in smaller form within the manual. We suggest that you retain the manual in your files for future reference, both in the use of the tuner and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with each part. Refer to the charts and other information shown on the inside covers of the manual to help identify any parts about which there may be a question. Hardware items are identified pictorially in the large manual fold in sheet. If some shortage is found in checking the parts, please notify us promptly and return the inspection slip with your letter to us. Hardware items are counted by weight and if a few are missing, please obtain them locally if at all possible. Handle the coils with care, for they are easily damaged and calibration will be destroyed if the screws are turned. The tuning condenser is also delicate and should be placed in a location where it will not be dropped accidentally. Keep the plates of this condenser fully meshed so they will not be bent.

Read the notes on soldering on the inside of the rear cover and the instructions under PROPER SOLDERING PROCEDURE. Crimp all leads tightly to the terminal before soldering. Be sure both the lead and terminal are free of wax, corrosion or other foreign substances. Use only the best rosin core solder, preferably a type containing the new activated fluxes such as Kester "Resin-Five," Ersin "Multicore" or similar types.

Resistors and controls generally have a tolerance rating of ±20% unless otherwise stated in the parts list. Therefore, a 100 KΩ resistor may test anywhere from 80 KΩ to 120 KΩ. (The letter K is commonly used to designate a multiplier of 1000.) Tolerances on capacitors are generally even greater. Limits of +100% and -50% are common for electrolytic capacitors. The parts furnished with your Heathkit have been specified so as to not adversely affect the operation of the finished instrument.

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are carefully checked before they are approved and the parts supplied will work satisfactorily. By checking the parts list for resistors, for example, you may find that a 120 KΩ resistor has been supplied in place of a 100 KΩ as shown in the parts list. These changes are self evident and are mentioned here only to prevent confusion in checking the contents of your kit.

We very strongly urge that you follow the wiring and parts layout shown in the manual. The position of wires and parts is quite critical in this tuner and changes may result in oscillation or other undesirable performance characteristics.

## STEP-BY-STEP ASSEMBLY INSTRUCTIONS

The Heathkit AM Tuner model BC-1 is a complex and critical instrument. We very strongly urge that the step-by-step instructions be followed exactly, rather than constructing the unit from pictorials and schematic alone. Special instructions regarding sequence of assembly and lead lengths are given to make construction of the kit as easy as possible. Wiring and mounting parts improperly may result in instability and it may be necessary to re-do work previously accomplished.

The following instructions are presented in a simple, logical, step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before you start to do it. When the step is completed, check it off in the space provided.

We suggest you do the following before any work is started:

1. Attach the large fold-in pictorials to the wall above your work space.
2. Go through the entire assembly and wiring instructions. This is an excellent time to read the entire instruction section through and familiarize yourself with the procedure.
3. Lay out all parts so that they are readily available. Refer to the general information inside the front and rear covers of this manual to help you identify components.

In assembling this kit, use lockwashers under all nuts, unless otherwise specified. Tube sockets are mounted on the wiring side of the chassis, the same as most other components. Other details of construction are included where pertinent in the instructions.

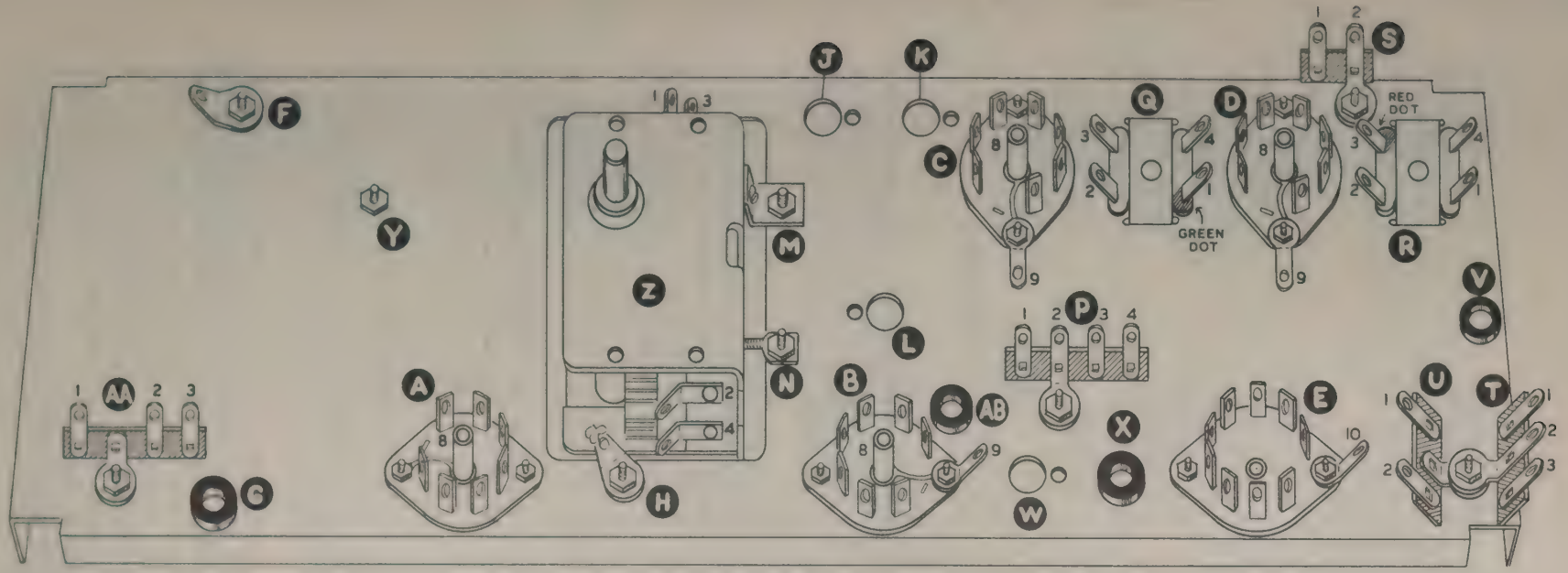



Figure 1

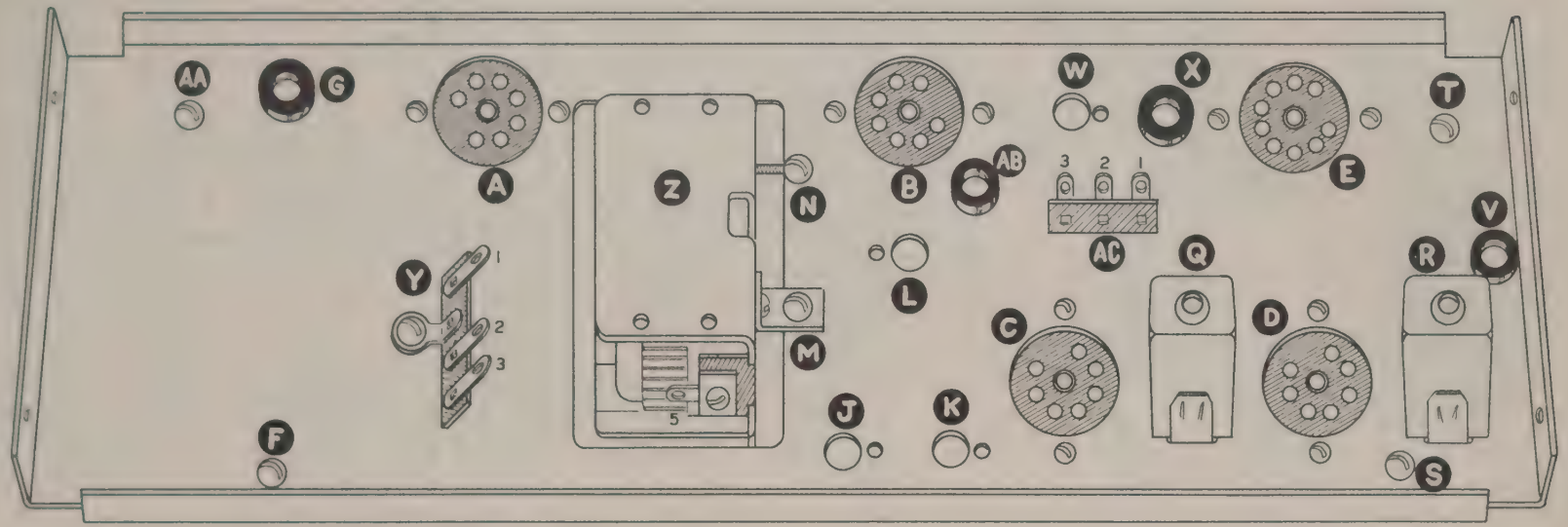



Figure 2

( ) Place the chassis on the bench so that it corresponds with Figure 1 on Page 11. The cutouts for the IF transformers must be located at the upper right. Note that this chassis is used in a different manner, in that all wiring is done on the OPEN side and this side is considered as the chassis BOTTOM. When observing the chassis with the flanges upward, you are looking at the TOP. If in doubt, check the pictorials and the inside photographs on Page 1.

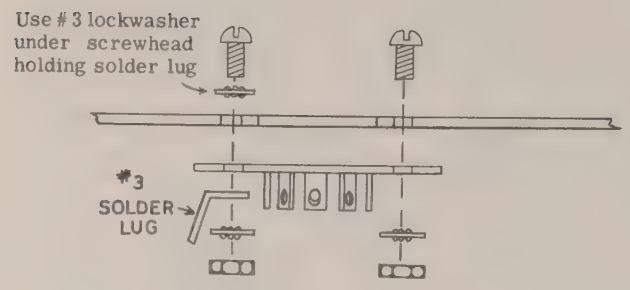



Figure 3

Figure 4

(✓) Mount a 7-pin tube socket at location A. Use 3-48 screws and nuts, with lockwashers under both nuts as shown in Figure 3. Make sure that the entire socket is mounted on the wiring or bottom side of the chassis. The pins will short to the chassis if the socket is mounted on top. Place the gap between pins 1 and 7 to the left as shown in Figure 1. Refer to Figure 4 and note the clockwise pin numbering sequence.

( ) Install a 7-pin socket at location B, mounting a ground lug under the right hand nut as shown. Orient the socket so that the gap is to the right. Bend the ground lug straight up.
( ) Mount a 7-pin socket at C, observing socket orientation. The blank space between pins 1 and 7 is toward the center of the chassis. Mount a ground lug under the centermost nut and bend up.

( ) In the same manner, install a 7-pin socket at D. Mount a ground lug under the nut nearest the chassis center and bend up.
( ) Mount a 9-pin socket at location E with the gap between pins 1 and 9 to the right as shown. Secure a ground lug under the nut next to this gap and bend it straight up.
( ) Mount 3/8" rubber grommets in holes G and X.
( ) Mount 5/16" rubber grommets in holes AB and V.

( ) Install a 3-lug terminal strip at location AA using 6-32 x 3/8 hardware. Orient as shown in Figure 1.
( ) Secure a #6 solder lug in place at location F with a 6-32 screw and nut. No lockwasher is needed since the lug incorporates a self-locking feature.

( ) Refer to Figures 1 and 2 and Figure 5 on Page 13. Place a 6-32 x 3/8 screw through a 3-lug terminal strip (1 lug grounded), through chassis location P from the top, a 4-lug terminal strip (1 lug grounded), a lockwasher and a nut. Observe the orientation of the two strips as shown in Figures 1 and 2.

(✓) Mount a 2-lug terminal strip (1 lug grounded) at location S, orienting as shown.
(✓) At location T, secure a 2-lug and a 3-lug (1 lug grounded) strip, with one 6-32 x 3/8 screw as shown. The 2-lug terminal strip must be nearest socket E.
(✓) On top of the chassis, mount a 3-lug terminal strip at location Y, orienting as shown in Figure 2.

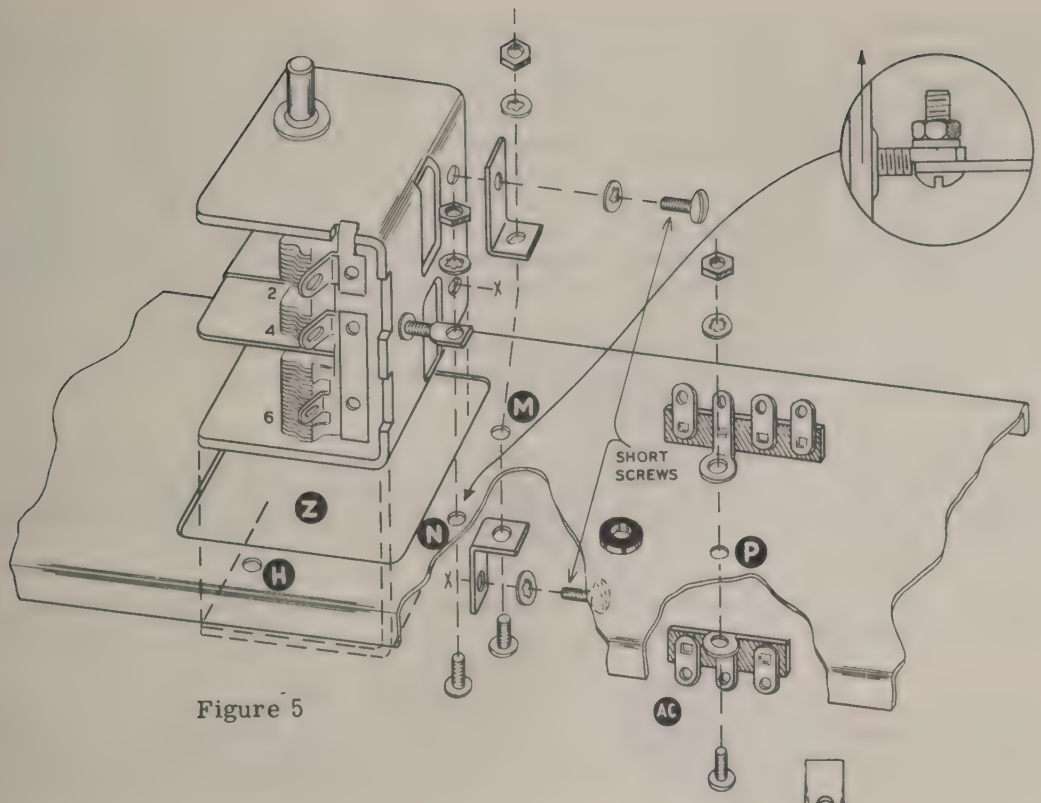



Figure 5

( ) Observe Figure 6 and mount the 52-9 output IF transformer (marked with a red dot on the base) at location R on top of the chassis. The red dot must be at the upper left hand corner, near pin 5 of socket D. Hold the transformer in place with your fingers or hold the assembly against the workbench and push a mounting clip through the two remaining chassis slots. Push one side down until the clip locks in place on one side of the transformer. Then push the other side down with a screwdriver until the end locks in place on the opposite side of the transformer.

( ) In the same manner, install the 52-8 input IF transformer which has a green dot on the base, at location Q with the green dot at the lower right, nearest pin 1 of socket D.

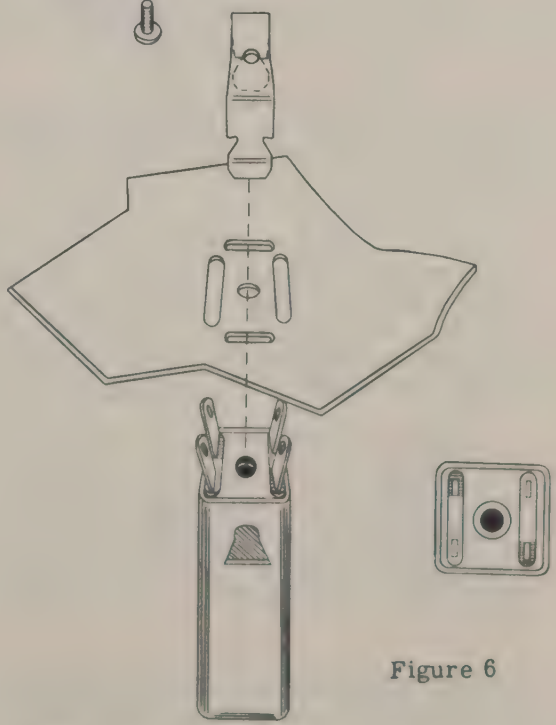


Figure 6

( ) Carefully inspect Figures 1, 2 and 5 to see how the tuning capacitor is installed. Start by loosely bolting the two small brackets in place at location M, with one bracket on each side of the chassis. The shortest bend should be in contact with the chassis on each side. Observe the bottom of the tuning capacitor and note that there are two tapped holes on one side and one on the other near the longitudinal center of the capacitor frame. Install the 6-32 spade bolt in the centermost single opening, turning it in about three turns. Note that the "spade" portion of this bolt is offset from center. This offset must be nearest the tuning capacitor drive shaft when the capacitor is installed.

Place the capacitor in position by dropping the back of the capacitor through opening Z, with the solid metal side toward openings M and N. Align the opening in the spade bolt with N and secure in place with 6-32 hardware. Align the other side of the capacitor with the openings in the brackets above and below chassis. Place a lockwasher over a short 6-32 x 3/16 screw and place this assembly through either bracket into the corresponding tapped hole in the tuning capacitor and tighten securely. Secure the remaining bracket to the capacitor in the same fashion. BE SURE to use the short 6-32 x 3/16 screws, for the longer 6-32 x 3/8 screws will short out the capacitor. Check to make sure the capacitor is squared up with the chassis opening. Adjustments can be made if necessary by turning the spade bolt in or out until symmetrical mounting is obtained. Now tighten all screws. Rotate the capacitor shaft gently through its full range once or twice to make sure all rotor plates clear the chassis. If necessary, the capacitor mounting brackets can be bent slightly to bring everything into proper alignment. Leave the capacitor plates fully meshed when making adjustments and when wiring the kit.

( ) Bend the remaining #6 solder lug so that it is flat and mount at location H with a 6-32 x 3/8 screw and nut. Orient the lug so that part of it lies over the center shield plate of the tuning capacitor. Make sure that it does not interfere with the capacitor rotation and solder it securely to the shield plate.

This completes the mechanical assembly of the chassis. The coils will be mounted later to avoid possible damage during earlier phases of wiring.

## PROPER SOLDERING PROCEDURE

Only a small percentage of Heathkit purchasers find it necessary to return an instrument for factory service. Of these, by far the largest proportion function improperly due to poor or improper soldering.

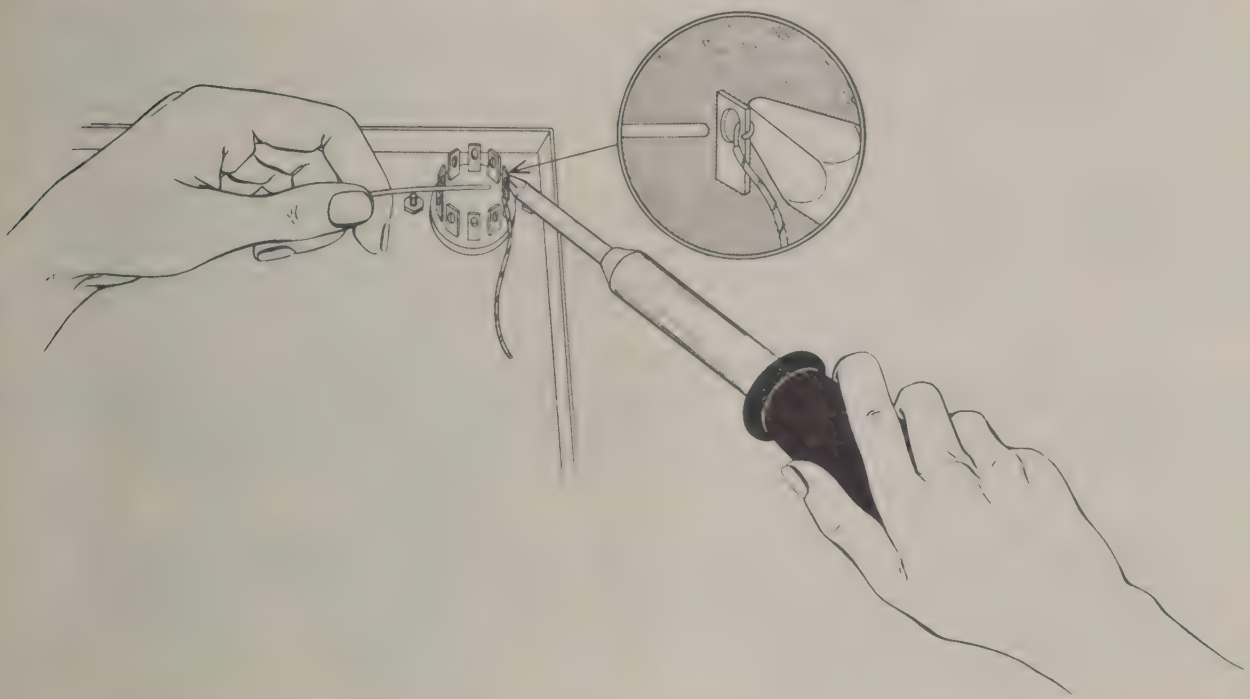
Correct soldering technique is extremely important. Good solder joints are essential if the performance engineered into the kit is to be fully realized. If you are a beginner with no experience in soldering, a half-hour's practice with odd lengths of wire and a tube socket will be a worthwhile investment.

High quality solder of the proper grade is most important. There are several different brands of solder on the market, each clearly marked "Rosin Core Radio Solder." Such solders consist of an alloy of tin and lead, usually in the proportion of 50:50. Minor variations exist in the mixture such as 40:60, 45:55, etc. with the first figure indicating the tin content. Radio solders are formed with one or more tubular holes through the center. These holes are filled with a rosin compound which acts as a flux or cleaning agent during the soldering operation.

NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes. Such compounds, although not corrosive at room temperatures, will form residues when heated. The residue is deposited on surrounding surfaces and attracts moisture. The resulting compound is not only corrosive but actually destroys the insulation value of non-conductors. Dust and dirt will tend to accumulate on these "bridges" and eventually will create erratic or degraded performance of the instrument.

NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.

If terminals are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good joint is made without relying on solder for physical strength. To make a good solder joint, the clean tip of the soldering iron should be placed against the joint to be soldered so that the terminal is heated sufficiently to melt solder. The solder is then placed against both the terminal and the tip of the iron and will immediately flow out over the joint. Refer to the sketch below. Use only enough solder to cover wires at the junction; it is not necessary to fill the entire hole in the terminal with solder. Excess solder may flow into tube socket contacts, ruining the socket, or it may creep into switch contacts and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.



A poor solder joint will usually be indicated by its appearance. The solder will stand up in a blob on top of the connection, with no evidence of flowing out caused by actual "wetting" of the contact. A crystalline or grainy texture on the solder surface, caused by movement of the joint before it solidified is another evidence of a "cold" connection. In either event, reheat the joint until the solder flows smoothly over the entire junction, cooling to a smooth, bright appearance. Photographs in the adjoining picture clearly indicate these two characteristics.

A good, clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 60 or 100 watt iron, or the equivalent in a soldering gun, is very satisfactory. Smaller irons generally will not heat the connections enough to flow the solder smoothly over the joint and are recommended only for light work, such as on etched circuit boards, etc. Keep the iron tip clean and bright. A pad of steel wool may be used to wipe the tip occasionally during use.

Take these precautions and use reasonable care during assembly of the kit. This will insure the wonderful satisfaction of having the instrument operate perfectly the first time it is turned on.

## WIRING OF THE AM TUNER

Pictorial 1 on Page 17 is a representation of the completed main chassis wiring. We again suggest that you use the large fold-in pictorials for reference as the work progresses. They are duplicates of the pictorials in the manual. Read the notes on the inside rear cover concerning wiring and soldering.

Refer to Pictorial 1. Note that each component part has been given a code designation which corresponds with the identification used during the assembly of the kit. In addition, each terminal on the part has also been assigned a number.

When the instructions read, "Connect one end of a 68 Ω resistor to tube socket B7 (NS)," it will be understood that the connection is to be made to contact pin 7 of tube socket B. The abbreviation "NS" indicates that the connection should not be soldered as yet, for other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this.

Unless otherwise indicated, all wire used is insulated. Wherever there is a possibility of bare leads on resistors and capacitors shorting to other parts or to chassis, the leads should be covered with insulated sleeving. This is indicated in the instructions by the phrase "use sleeving." Bare wire is used where lead lengths are short and the possibility of short circuits nonexistent.

Leads on resistors, capacitors and transformers are generally much longer than they need to be to make the indicated connections. In these cases, the excess leads should be cut off before the part is added to the chassis. In general, the leads should be just long enough to reach their terminating points. Not only does this make the wiring much neater, but in many instances the excessively long leads will actually lead to instability or oscillation.

The pictorials indicate actual chassis wiring, designate values of the component parts and show color coding of leads where pertinent. We very strongly urge that the chassis layout, lead placement and grounding connections be followed exactly as shown. While the arrangement shown is probably not the only satisfactory layout, it is the result of considerable experimentation and trial. If the layout is followed carefully, it will result in a stable instrument operating at a high degree of sensitivity and dependability.

Space has been provided for you to check off each operation as it is completed. This is particularly important in wiring and it may prevent omissions or errors, especially where your work is interrupted frequently as the wiring progresses. Some kit builders have also found it helpful to mark each lead in colored pencil on the pictorial as it is added.

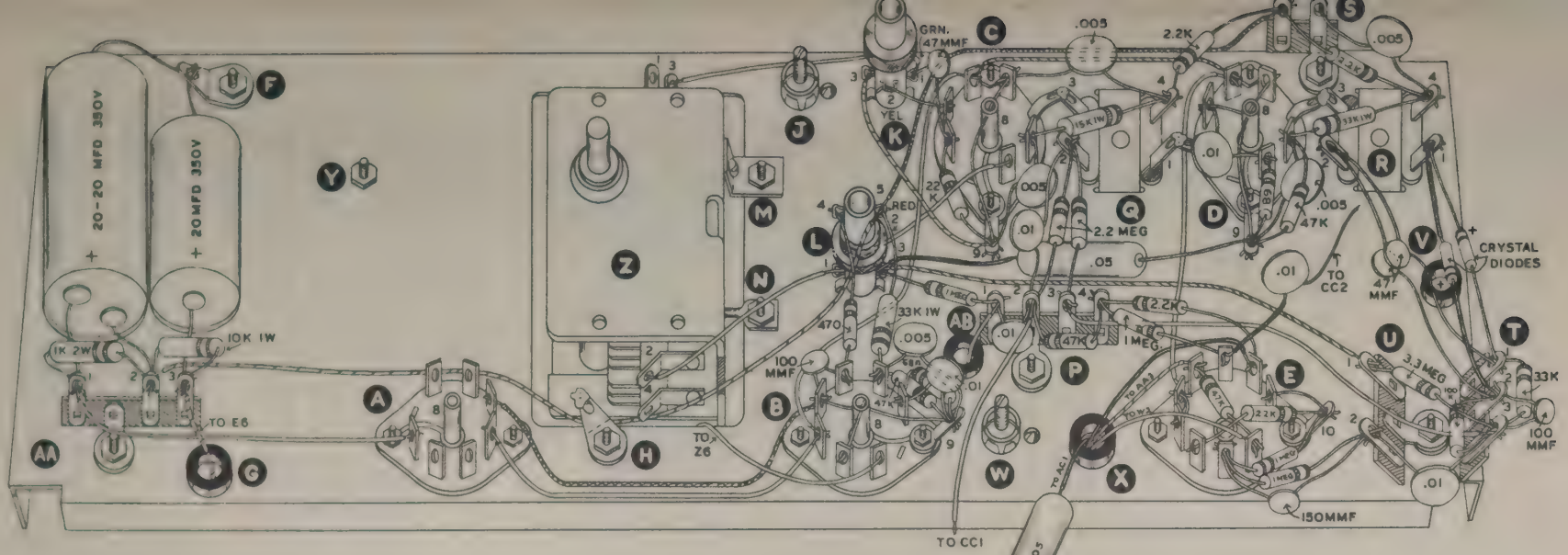
Note that a number appears after each solder (S) instruction. This number indicates the number of leads connected to the terminal in question. For example, if the instructions read, "Connect a 47 KΩ resistor from socket E1 (S-2) to E6 (NS), "it will be understood that there will be two leads connected to the terminal at the time it is soldered. This additional check will help avoid errors.

## STEP-BY-STEP WIRING INSTRUCTIONS

( ) Connect a short piece of bare wire from tube socket B4 (NS) through center post B8 (NS) to ground lug B9 (NS). Wrap the wire around the ground lug near to the chassis to make room for other components which will be added later. See Pictorial 1 on Page 17.

( ) Connect a short bare wire from socket B2 (S-1) to center post B8 (S-2).

NOTE: Good solder connections are essential if stable and reliable performance is to be obtained. If not thoroughly familiar with good soldering technique, it is recommended that the paragraphs under PROPER SOLDERING PROCEDURE be reviewed at this time. Careful attention to soldering procedure may save considerable trouble-shooting time upon completion of the tuner.




PICTORIAL 1

PICTORIAL 2

( ) Run a short bare wire from socket C4 (NS) through center post C8 (NS) to ground lug C9 (NS). Now solder center post C8 (S-1).
( ) In a similar manner, connect a short bare wire from socket D4 (NS) through center post D8 (NS) to ground lug D9 (NS). Now solder D4 (S-1).
( ) Connect a short bare wire from socket D2 (NS) to center post D8 (S-2).
( ) Connect a short piece of bare wire from socket E4 (S-1) to E5 (NS).

( ) Run a bare wire from socket E9 (S-1) to ground lug E10 (NS).
( ) Route an insulated wire from socket A3 (NS) to socket B4 (NS), dressing it tight to chassis as shown in Pictorial 1.
( ) Run a wire from socket A4 (NS) to socket B3 (NS).
( ) Connect a wire from socket B3 (S-2) to socket C3 (NS). Dress tight to chassis, to the right of openings L and K.

( ) Connect a wire from socket C3 (S-2) to socket D3 (NS).
( ) Run a wire from socket D3 (S-2) to socket E5 (S-2).

This completes the filament wiring for all tubes except the pilot lamp, which will be wired later. Before continuing the wiring, check all sockets to see that none of the bare or insulated wires are touching any contacts other than those to which they are attached. If wires are close to contacts, bend them away slightly to avoid the possibility of short circuits.

( ) Connect a wire from socket A7 (S-1) to terminal strip AA1 (NS).
( ) Route a wire from terminal strip AA3 (NS) through grommet G, along the top of the chassis, back down through grommet X to socket E6 (NS). Dress along the bend at the edge of the chassis.

NOTE: The importance of short component and wire leads in high frequency equipment such as the Heathkit BC-1 Tuner cannot be overemphasized. Long leads will cause instability, oscillation and loss of sensitivity. Unusually close wiring is employed in all signal carrying stages but it is not difficult if the instructions are followed exactly. "Picture wiring" is not recommended since the lead lengths become excessively long, even though the wiring may look much more attractive. The shortest distance between two points is always a straight line.

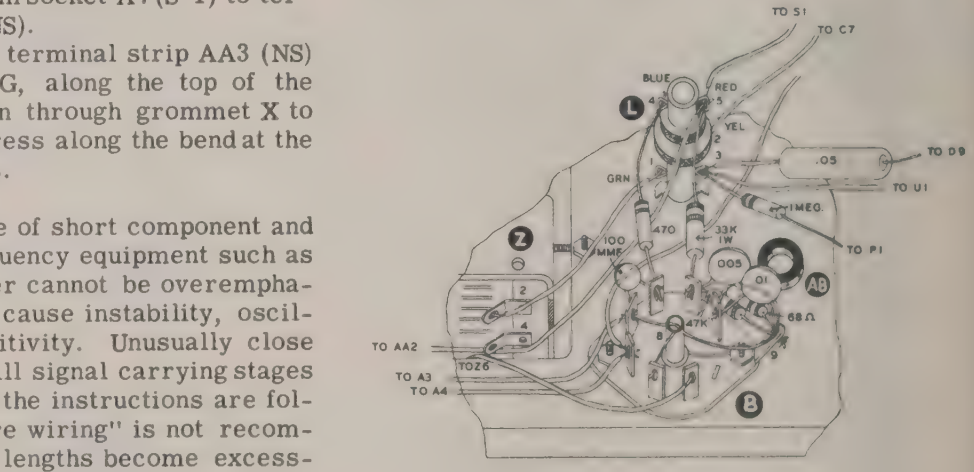



Figure 7

( ) Install a .005 μfd disc capacitor from socket B6 (NS) to ground lug B9 (NS).
( ) Connect a 47 KΩ resistor (yellow-violet-orange) from socket B6 (NS) to ground lug B9 (NS). Observe Figure 7 to see how components are mounted and dressed.
( ) Connect a 68 Ω resistor (blue-gray-black) from socket B7 (NS) to ground lug B9 (NS).
( ) Install a .01 μfd disc capacitor from socket B7 (S-2) to ground lug B9 (S-5). Dress the capacitor vertical in respect to chassis. Make sure the solder flows smoothly over ALL of the leads connected to ground lug B9.

( ) Mount a 100 μμf disc capacitor from socket B4 (S-3) to B5 (NS).
( ) Run a wire from socket B1 (S-1) to tuning capacitor lug Z6 (NS). Z6 appears on top of the chassis nearest socket B. Dress the wire through the large cutout as shown.
( ) Carefully mount the 40-88 mixer coil at location L. Line the tab on one side of the mounting clip up with the small opening next to hole L and push the coil in from the bottom until the tabs click and lock in place. The mixer coil can be readily identified, since it is the only coil with two separate windings and five lugs.

( ) Connect a wire from tuning capacitor Z2 (S-1) to coil terminal L1 (S-1). L1 is marked with a green dot. Exercise extreme care when soldering to or near any of the coils. Do not let the soldering iron touch the coils, or let solder splashes get on them, as they may be permanently damaged.

( ) Run a wire from unmarked coil lug L3 (NS) to terminal strip U1 (NS). Dress tight to chassis.

( ) Install a 1 megohm resistor (brown-black-green) from coil lug L3 (NS) to terminal strip P1 (NS).

( ) Connect a .05 μfd tubular capacitor from coil L3 (S-3) (use sleeving) to socket ground lug D9 (NS).

( ) Run a wire from terminal strip AA2 (NS) to red dot coil lug L5 (NS). Dress close to chassis up to the coil, then straight up to L5. It may be helpful to run this wire under solder lug H, since this will help hold the wire in place. See Pictorial 1.

( ) Connect a wire from coil lug L5 (NS) to terminal strip S1 (NS). Dress the wire straight down to the chassis, then over to S1.

( ) Connect a 33 KΩ 1 watt resistor (orange-orange-orange, medium size) from coil L5 (S-3) to socket B6 (S-3).

( ) Install a 470 Ω resistor (yellow-violet-brown) from blue dot coil lug L4 (S-1) to socket B5 (S-2).

This completes the wiring of the 6BA6 RF amplifier stage. Carefully check all connections for secure soldering and make sure no short circuits exist.

( ) Inspect the 20-20 μfd 350 volt electrolytic filter capacitor. Note that two leads appear at one end and one at the other. Mount the capacitor so that the end with two leads is toward terminal strip AA. Place one of the leads through AA1 and the other through AA2. Push the capacitor close to the terminal strip. Secure the connection at AA1 (NS) and AA2 (NS).

( ) Connect the single lead at the opposite end of the capacitor to ground lug F (NS).

( ) Install the single section 20 μfd electrolytic capacitor from terminal strip AA3 (NS) to ground lug F (S-2). The positive (+) end must connect to AA3.

( ) Connect a 1 KΩ 2 watt resistor (brown-black-red, large size) from terminal strip AA1 (S-3) to AA2 (NS).

( ) Connect a 10 KΩ 1 watt resistor (brown-black-orange, medium size) from AA2 (S-4) to AA3 (S-3).

This completes the wiring of the high voltage distribution points and the filter system.

( ) Connect a 22 KΩ resistor (red-red-orange) from socket C1 (NS) to ground lug C9 (NS). See Figure 8.

( ) Connect a .005 μfd disc capacitor from socket C4 (S-2) to IF transformer Q4 (NS).

( ) Bend socket lug C5 and IF transformer lug Q3 toward each other until they make contact and overlap slightly. Solder the connection securely. (1).

( ) Install a .005 μfd capacitor from socket C6 (NS) to ground lug C9 (NS). Dress the capacitor close to chassis, under the .05 μfd capacitor previously installed.

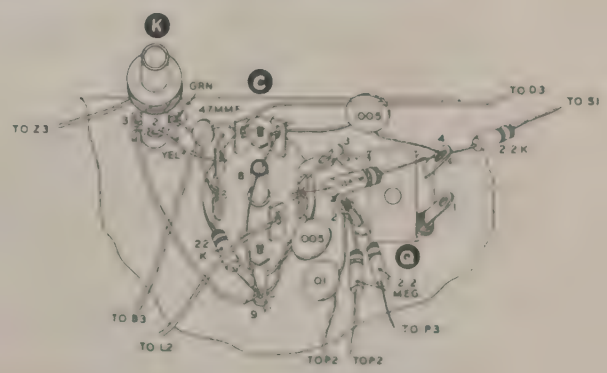



Figure 8

( ) Connect a 15 KΩ 1 watt resistor (brown-green-orange, medium size) from socket C6 (S-2) to IF transformer Q4 (NS). Dress the resistor so that the opening at the bottom of the transformer is left clear.

( ) Run a 2.2 KΩ resistor (red-red-red) from terminal strip S1 (NS) to IF transformer Q4 (S-3).
( ) Identify the 40-89 oscillator coil, which has three lugs. Mount this coil at location K, inserting from the bottom of the chassis with the lug oriented as shown in Pictorial 1 and Figure 8. Push gently until the coil locks in position.
( ) Run a short piece of bare wire from yellow marked coil lug K2 (S-1) to socket C2 (S-1).

( ) Connect a 47 μμf disc capacitor from green marked coil lug K1 (NS) to socket C1 (S-2).
( ) Connect a wire from green marked coil lug K1 (S-2) to tuning capacitor Z3 (S-1).
( ) Connect a wire from unmarked coil lug K3 (S-1) to ground lug C9 (S-4). Make sure the solder flows smoothly over all leads connected to C9.
( ) Connect a wire from yellow marked coil lug L2 (S-1) to socket C7 (S-1).

This completes the wiring of the oscillator-mixer stage. Carefully inspect the unit for loose connections, short circuits and poor solder joints. Clean out all clippings and solder splashes.

( ) Run a wire from terminal strip T3 (NS) to terminal strip P3 (NS). Dress the wire between terminal strip lugs U1 and U2, then tight to chassis over to P3.
( ) Connect a 2.2 megohm resistor (red-red-green) from terminal strip P3 (S-2) to IF transformer Q2 (NS).
( ) Bend IF transformer lug Q1 and socket pin D1 toward each other until they overlap slightly and make physical contact. Solder the junction securely (1).

( ) In the same fashion, bend socket pin D5 and IF transformer R3 together and solder (1).
( ) Connect a .005 μfd disc capacitor from socket D6 (NS) to ground lug D9(NS). Dress close to chassis.
( ) Connect a 47 KΩ resistor (yellow-violet-orange) from socket D6 (NS) to ground lug D9(NS).
( ) Install a 33 KΩ 1 watt resistor (orange-orange-orange, medium size) from socket D6 (S-3) to IF transformer R4 (NS). Dress the resistor body so that it leaves the transformer alignment opening clear.

( ) Mount a 68 Ω resistor (blue-gray-black) from socket D7 (NS) to ground lug D9 (S-5). Make sure the solder flows smoothly over all leads connected to D9.
( ) Connect a .01 μfd disc capacitor from socket D7 (S-2) to D2 (S-2).
( ) Install a 2.2 megohm resistor (red-red-green) from IF transformer Q2 (NS) to terminal strip P2 (NS).
( ) Connect a .01 μfd disc capacitor from IF transformer Q2 (S-3) to terminal strip P2 (NS).

(✓) Connect a .005 μfd disc capacitor from IF transformer R4 (NS) to terminal strip S2 (S-1).
(✓) Run a 2.2 KΩ resistor (red-red-red) from terminal strip S1 (S-3) to IF transformer R4 (S-3).

Wiring of the 6BA6 IF amplifier stage is now complete. Once again, carefully check for short circuits and defective connections. Remove all clippings and solder splashes that may be present.

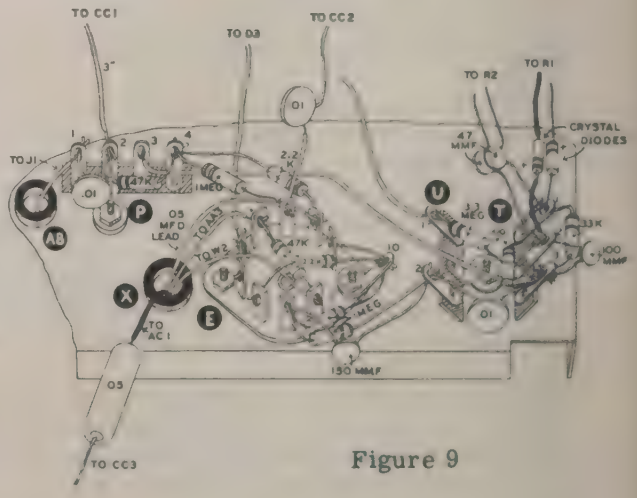


Figure 9

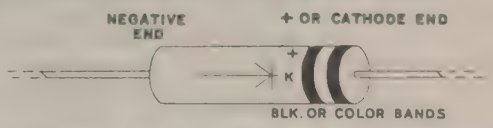
(✓) Connect a 47 μμf disc capacitor from IF transformer R2 (NS) to terminal strip T2 (NS). See Figure 9.
(✓) Connect a 47 μμf disc capacitor from R2 (S-2) to terminal strip T1 (NS).

( ) Install a 33 KΩ resistor (orange-orange-orange) from terminal strip T1 (NS) to T3 (NS). Dress tight to the outside of the terminal strip.

( ) Mount a 100 $\mu\mu$f disc capacitor from terminal strip T2 (NS) to T3 (NS). Dress close to the strip on the outside so that it does not protrude beyond the end of the chassis.

( ) Connect a 100 KΩ resistor (brown-black-yellow) from terminal strip T3 (NS) to T2 (NS). Dress between terminal strips T and U.

( ) Connect a crystal diode from IF transformer R1 (NS) to terminal strip T1 (S-3). The cathode end MUST connect to R1. Keep heat away from the diode by placing a heat block, such as a pair of pliers, between the diode and the solder connection.




ONE OR MORE OF THE ABOVE MARKINGS WILL APPEAR ON ALL TYPES OF CRYSTAL DIODES.

Figure 10

IMPORTANT: The cathode end of a crystal diode will be identified by a band or several colored bands, the letter K, a + sign, or by the symbol shown in Figure 10. If a letter and color bands appear, disregard the letter.

( ) Connect the remaining crystal diode from IF transformer R1 (S-2) (use sleeving) to terminal strip T2 (S-4) (use sleeving). The cathode end MUST be connected to T2. Protect the diodes from heat as before.

( ) Mount the 40-90 10 kc whistle filter coil at location W from the TOP of the chassis as shown in Pictorial 2.

( ) Run a wire from socket E1 (NS) through grommet X to unmarked coil lug W2 (NS). Dress the wire over pins 4 and 5 of socket E.

( ) Slip sleeving over one end of a .05 $\mu$fd tubular capacitor. Do not cut the lead. Place this lead through grommet X from the top of the chassis. Connect this lead to socket E8 (NS). Dress the lead close to chassis and leave the other end free. Bend the capacitor out of the way if necessary.

( ) Connect a 3.3 megohm resistor (orange-orange-green) from terminal strip T3 (NS) to terminal strip U1 (S-2).

( ) Install a 47 KΩ resistor (yellow-violet-orange) from socket E1 (S-2) across the socket to E6 (S-2).

( ) Connect a 1 megohm resistor (brown-black-green) from socket E2 (NS) to ground lug E10 (NS). Dress close to the socket and chassis.

( ) Connect a 2.2 KΩ resistor (red-red-red) from socket E3 (S-1) to ground lug E10 (S-3). Dress across the socket, over the 47 KΩ resistor previously installed.

( ) Run a 1 megohm resistor (brown-black-green) from terminal strip U2 (NS) to socket E2 (NS).

( ) Connect a 150 $\mu\mu$f disc capacitor from terminal strip U2 (NS) to socket E2 (S-3).

( ) Install a .01 $\mu$fd disc capacitor from terminal strip T3 (S-6) to terminal strip U2 (S-3).

( ) Connect a 47 KΩ resistor (yellow-violet-orange) from terminal strip P2 (NS) to P4 (NS).

( ) Connect a 1 megohm resistor (brown-black-green) from socket E7 (NS) to terminal strip P4 (NS).

( ) Mount a 2.2 KΩ resistor (red-red-red) from socket E8 (S-2) to terminal strip P4 (S-3).

( ) Connect a .01 $\mu$fd disc capacitor from terminal strip P1 (NS) to P2 (NS).

( ) Cut one lead of a .01 $\mu$fd disc capacitor to a length of 1". Slip sleeving over this lead and connect it to socket E7 (S-2). Leave the other end free, dressing it out of the way.

( ) Cut a wire to a length of 3". Strip and tin both ends and connect one end to terminal strip P2 (S-5). Leave the other end free, dressing it out of the way.

( ) Mount the 4-lug antenna coil at location J on TOP of the chassis. The green marked lug must be nearest coil K.

( ) Run a wire from terminal strip P1 (S-3) through grommet AB, to the yellow marked antenna coil lug J1 (S-1). Take care not to burn or splash solder on the coil.

( ) On top of the chassis, connect a wire from green marked coil lug J2 (S-1) to tuning capacitor Z5 (S-1).

( ) Connect a short wire from whistle filter coil red marked lug W1 (S-1) to terminal strip AC1 (NS).
( ) Install a .002 μfd disc capacitor from unmarked coil lug W2 (S-2) to terminal strip AC3 (NS).
( ) Connect an 82 KΩ resistor (gray-red-orange) from terminal strip AC2 (NS) to AC3 (NS). Dress close to the terminal strip and chassis.
( ) Mount a .002 μfd disc capacitor from terminal strip AC1 (NS) to AC3 (S-3).
( ) Connect a 270 μμf disc capacitor from terminal strip AC1 (NS) to AC2 (NS).

( ) Cut a wire to a length of 2 1/2". Strip and tin both ends and connect one end to terminal strip AC2 (S-3). Leave the other end free.
( ) Cut one lead of a .05 μfd tubular capacitor to a length of 1 3/4". Slip sleeving over this lead and insert through grommet X from the chassis BOTTOM. Connect this lead to terminal strip AC1 (NS). Leave the other end free.
( ) Cut one lead of a .05 μfd tubular capacitor to a length of 1/2". Connect this lead to terminal strip AC1 (S-5). Leave the other end free.

This completes the wiring of the chassis part of the detector, audio amplifier and whistle filter. The chassis is also complete. Clean out clippings and solder splashes and carefully check the entire chassis for short circuits. Compare the chassis against Pictorials 1 and 2, looking for errors in wiring. A little time spent at this point may save a considerable amount of trouble upon completion of the kit. If any wires or component leads appear longer than they absolutely need to be, it will be worthwhile to shorten them. Several points will be found not soldered when checking. Do not solder A3, A4 or Z6.

( ) Identify the left end bracket, which is plain aluminum with bends on the bottom and one end only. See Figure 11. Install a 3/8" grommet at location BA.
( ) Install large diameter 7/16" soft rubber grommets at locations BH and BJ.

( ) Insert a 3/16" metal spacer in the center of each large grommet as shown in Figure 12.
( ) Using the two heavy 8-32 screws, mount the power transformer on the left bracket, placing #8 lockwashers under the nuts. Note that the screws are inserted outside the bracket through holes BB and BC and the lockwashers and nuts are on the transformer side. The red and red-yellow leads should be nearest grommet BA.

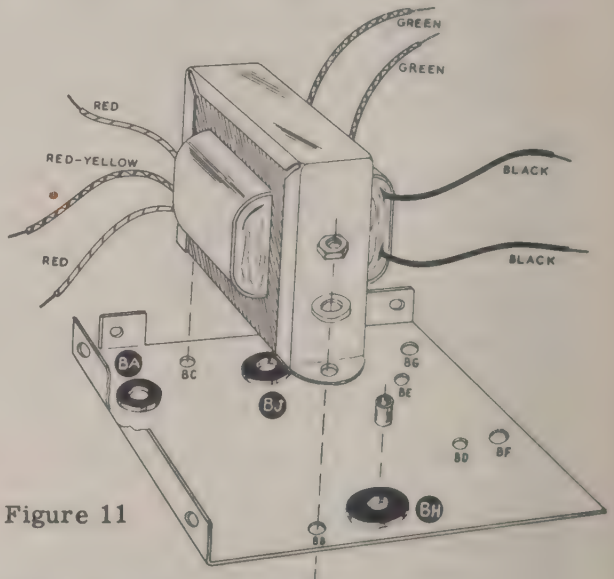


Figure 11

( ) Mount bracket B on the left or tuning capacitor end of the chassis, with the transformer fitting over the chassis top as in Figure 13 on Page 23. Place a 9/16" washer on a 6-32 self-tapping screw and insert through the spacer previously installed in grommet BH. Line the screw up with the top chassis opening and secure the assembly. Before completely tightening the screw, start the second self-tapping screw and washer through the bottom opening BJ. Now tighten both screws.

( ) Install two 7/16" grommets in the large openings in the right hand bracket and insert the 3/16" spacers in each grommet. Install the bracket on the right hand end of the chassis in the same fashion. The large hole should be forward. See Figure 13.

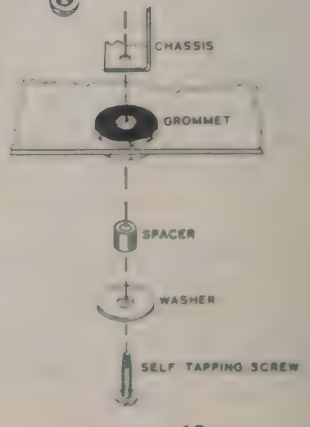


Figure 12

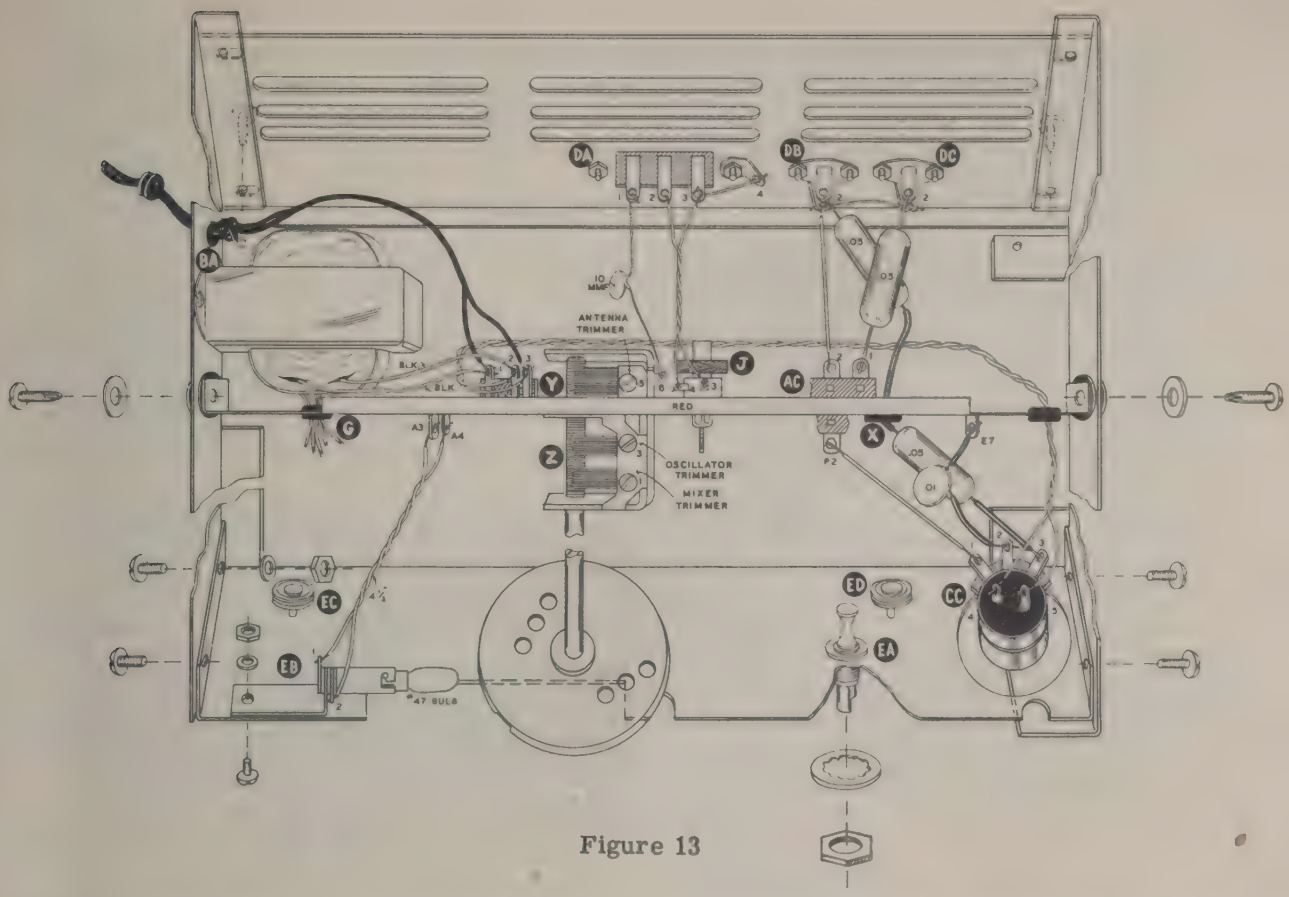



Figure 13

( ) Place the red, red-yellow and green power transformer leads through grommet G on the chassis. Cut one green lead to length sufficient to reach socket A3, strip and tin the lead and connect it to A3 (NS).
( ) In the same fashion, connect the remaining green lead to socket A4 (NS).
( ) Similarly, connect the red-yellow lead to socket A3 (NS).
( ) Connect a red lead to socket A1 (S-1).
( ) In the same manner, connect the remaining red lead to socket A6 (S-1).

( ) On top of the chassis, connect one black transformer lead to terminal strip Y1 (NS). See Pictorial 2.
( ) Connect the remaining black lead to terminal strip Y2 (NS).
( ) Install an 8-32 set screw in the bushing and mount the large condenser drive pulley on the tuning capacitor shaft with the pulley nearest the capacitor frame. With the capacitor plates fully meshed, orient the opening in the outer edge of the pulley so that it is toward ground lug F on the chassis. The edge of the bushing must be flush with the end of the tuning capacitor shaft when the set screw is tightened.

( ) Mount the dial plate as shown in Figure 13, with the calibration directly below the tuning capacitor drum. Secure with 6-32 screws, lockwashers and nuts in the four foremost holes in the end brackets.
( ) Prepare volume control CC as shown in Figure 14. Cut two wires to a length of 14". Hold an end of each wire evenly together and twist the pair together up to approximately 1" from each end. Strip and tin all four ends.

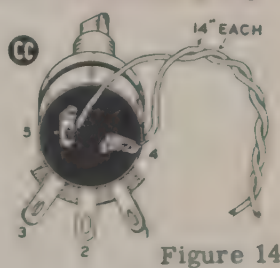
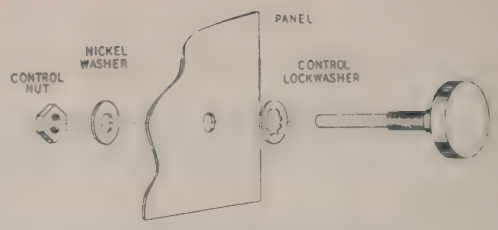



Figure 14

( ) At one end of this cable, connect one lead to control switch terminal CC4 (S-1) and the remaining free end to CC5 (S-1).

(✓) Place a large lockwasher over the control shaft and temporarily install the control through the openings provided in the dial plate and right end bracket. See Figure 15. Orient the control so that lugs 1, 2 and 3 are toward the tuning capacitor and tighten the assembly in place.



HOW TO MOUNT CONTROLS & SWITCHES.

Figure 15

(✓) Pass the twisted leads from CC4 and CC5 through chassis grommet V and dress along the lower chassis lip, close to the chassis as shown in Pictorial 2. Bring the wires around socket A and in back of terminal strip Y. Connect one lead to Y2 (S-2) and the other to Y3 (NS).

( ) Run the free end of the wire connected to terminal strip P2 to control lug CC1 (S-1).

( ) Cut the free lead of the .01 μfd disc capacitor connected to socket E7 to a length of 1". Slip sleeving over this lead and connect it to CC2 (S-1).

(✓) Cut the free lead of the .05 μfd tubular capacitor appearing through grommet X to a length of 1 1/2". Slip sleeving over this lead and connect it to CC3 (S-1).

(✓) Loosen the control nut and rotate the control so that lugs 1, 2 and 3 point straight down, over terminal strips T and U. Carefully check all leads and components connected to the volume control to make sure no short circuits exist.

(✓) Slip a 3/8" rubber grommet over the line cord and pass the cord through grommet BA in the left end bracket from the outside. DO NOT forget the grommet on the line cord. Tie a knot approximately 5" from the end for strain relief. Connect one line cord lead to terminal strip Y1 (S-2) and the remaining lead to Y3 (S-2).

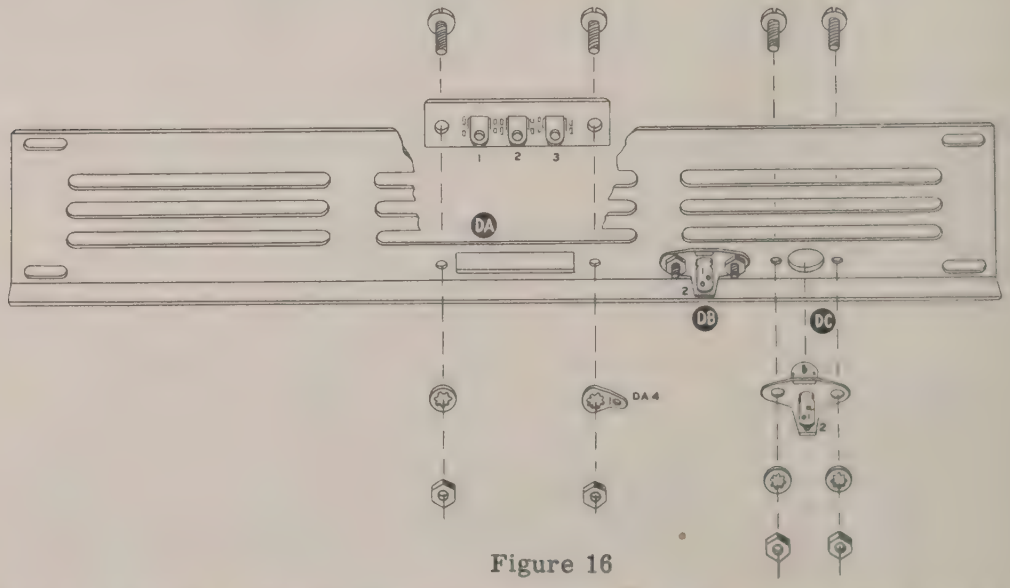



Figure 16

( ) Mount a 3-lug screw type terminal strip at location DA on the back panel with 6-32 hardware. The strip mounts on the outside, or painted side of the panel as shown in Figure 16. Note that a #6 ground lug is used under the nut nearest DB.

( ) Install a phono connector at DB on the rear panel with 6-32 hardware. Note that these connectors are installed inside the panel as shown in Figure 16. The ground lug should be nearest the panel flange.

(✓) In the same manner, install a phono connector at DC.

( ) Install the back plate with the bent flange at the bottom. Use 6-32 self-tapping screws in the bottom holes at each end ONLY, as shown in Figure 13.

( ) Connect a bare wire from connector ground lug DB2 (NS) to connector ground lug DC2 (S-1).

( ) Cut the free lead of the .05 μfd capacitor connected to terminal strip AC1 to a length sufficient to reach and connect the lead to connector DC1 (S-1).
( ) Connect the free lead of the remaining .05 μfd capacitor to connector DB1 (S-1).
( ) Connect the free end of the wire connected to terminal strip AC2 to connector ground lug DB2 (S-2).
( ) Run a short bare wire from antenna terminal DA3 (NS) to ground lug DA4 (S-1).

( ) Cut two wires to a length of 4". Strip and tin all four ends and holding the ends even, twist the pair together. At one end, connect one lead to antenna coil unmarked lug J3 (S-1) and the other lead to red marked lug J4 (S-1).
( ) At the opposite end of the twisted pair, connect one lead to antenna terminal strip DA3 (S-2) and the remaining lead to DA2 (S-1).
( ) Install a 10 μμf disc capacitor from antenna terminal strip DA1 (S-1) to tuning capacitor Z6 (S-2).

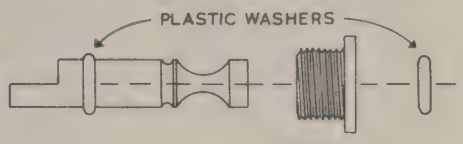
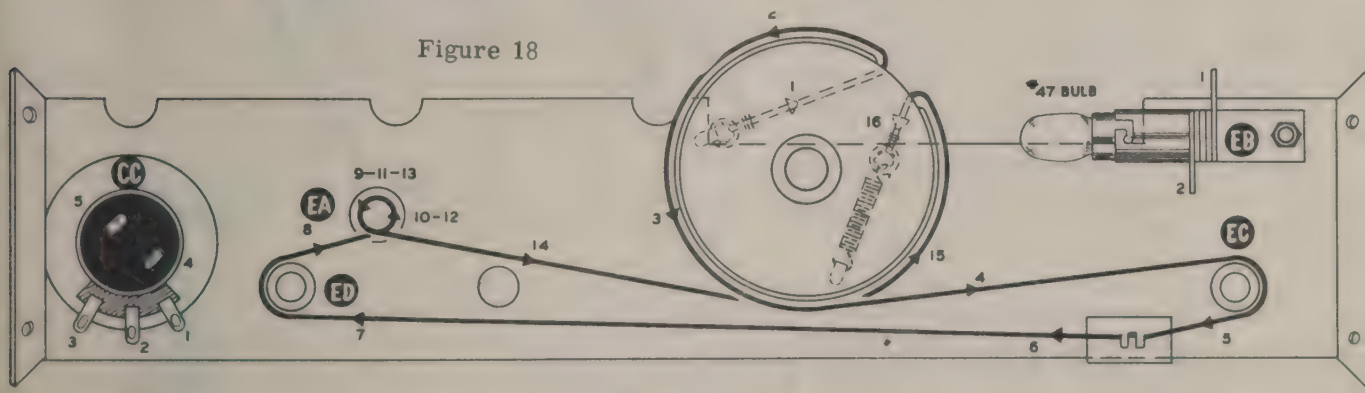


Figure 17

( ) Assemble the dial drive shaft assembly as shown in Figure 17. Begin by pushing one of the plastic "O" washers on the shaft from the flatted end until it falls in place in the slot provided for it. Do not use tools with sharp edges to force the washer over the edge of the flat, for it is possible that the washer will be broken. After the first washer is in place, a small amount of heavy lubricant such as Lubriplate or Vaseline should be wiped on the shaft between the two cutouts for the plastic washers. Use sparingly as any excess will find its way to the dial cord and cause slippage. Light oil may be used, but very sparingly. Install the shaft in the bushing in the direction shown in Figure 17 and install the other plastic washer from the drive side of the shaft. A spare washer is furnished in case of accidental damage during installation.

Figure 18




( ) Mount the drive shaft assembly through the dial plate from the rear at location EA. Refer to Figure 13 and note that the bushing goes through the dial plate, a large lockwasher and a control nut. Tighten securely.
( ) Observe Figure 18 and install the dial cord assembly. Begin by hooking one of the eyelets over the ear provided on the tuning drum. Run the cord counterclockwise around the pulley (looking from the back of the tuner), around idler pulley EC, across the dial plate to idler pulley ED, around drive shaft EA three turns and back to the bottom side of the drum. Bring the cord counterclockwise around the drum and through the opening. Hook the dial cord spring on the remaining ear on the drum and the other end of the spring to the eyelet on the dial cord.

( ) Install the dial pointer up from the bottom of the dial plate. Spread the three prongs and place the dial cord between them. With the tuning capacitor fully closed, set the pointer over the mark to the left of "550" on the dial. Pinch the lugs together to secure the pointer in place, taking care not to cut the cord. Turn the tuning control through its entire range to make sure everything operates properly.

( ) Cut two wires to a length of 4 1/2". Strip and tin all four ends and twist the two wires together as before. At one end, connect one of the wires to pilot lamp socket EB1 (S-1) and the other to EB2 (S-1).

( ) Mount the pilot lamp socket at location EB on the dial plate with 6-32 hardware. The screw goes through the small hole at the left end of the dial plate, the socket, a lockwasher and nut. The socket is oriented parallel with the dial plate edge toward the tuning capacitor. Bend the socket slightly toward the dial plate if bright illumination of the dial is desired.

( ) Connect the free end of one of the wires connected to pilot lamp socket EB to socket A3 (S-4) and the remaining wire to A4 (S-3).

NOTE: Six feet of audio cable is furnished with the kit and this should be sufficient for the average installation. It is always good practice to mount the various components of a high fidelity installation as close together as feasible, with the exception of the speaker system. Long audio cables between components cause loss of high frequency response unless the output impedance is very low. The output impedance at the fixed level jack is approximately 50 KΩ, which is relatively high. RG58A/U cable, furnished with the kit, has a capacity of approximately 28.5 μμf per foot, or 171 μμf for the entire six foot length. This capacity will cause the output to be down approximately 1 1/2 db at 10,000 cycles, so longer cable should not be used at the fixed output, unless the cable has lower capacity. If it is possible to use a shorter length, do so by all means, since the high frequency performance will be improved. Refer to the OUTPUTS section under INSTALLATION in this manual.

Output impedance at the variable output is quite low since signal is taken from a cathode follower. Up to 100 feet of shielded microphone cable, or up to 200 feet of RG58A/U coaxial cable may be used between the tuner and preamplifier with not more than 3 db loss at 10,000 cycles. With extreme lengths, hum might become a serious problem, so the cable length should be just long enough to meet the requirements of the installation for best performance.

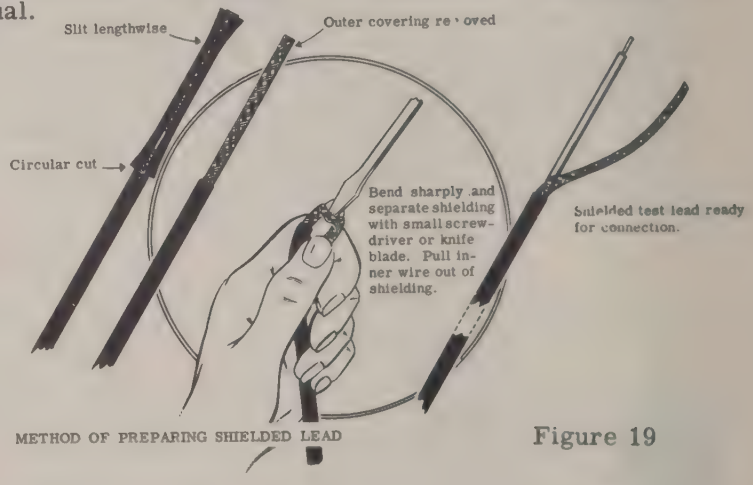

Slit lengthwise
Outer covering removed
Circular cut
Bend sharply and separate shielding with small screwdriver or knife blade. Pull inner wire out of shielding.
Shielded test lead ready for connection.
METHOD OF PREPARING SHIELDED LEAD

Figure 19

( ) Prepare the audio cable. Strip approximately 1" of outer rubber insulation from each end of the cable. At each end, bend the exposed shielding braid over and make an opening in it with a sharp pointed tool of some kind, such as an icepick. Pull the insulated inner conductor through and strip away approximately 5/8" of insulation. Check with Figure 19.

Figure 20

( ) Install the phono connectors on each end of the cable as shown in Figure 20. Insert the prepared inner conductor through the back of the connector until it will go no further. A small amount of wire should show at the tip of the connector. Solder the wire to the connector at this point. Next, wrap the shield braid around the plug shell and solder securely. Repeat the operation for the opposite end of the cable, unless the audio equipment to be used with the tuner uses some other type of connector.

( ) Prepare the low impedance electrostatically shielded antenna. Cut off exactly 12 feet of the 2-conductor shielded cable. At each end of this cable, cut away 1 1/2" of outside rubber insulation as shown in Figure 19. Unwind or inbraid the shield at each end and twist to form a pigtail. Strip away about 1/4" of insulation from all four ends of the inner conductors. Connect the yellow wire at one end of the cable to the green wire at the other end and solder securely. Wrap with electrical tape to insulate the connection. See Figure 21 on Page 27.

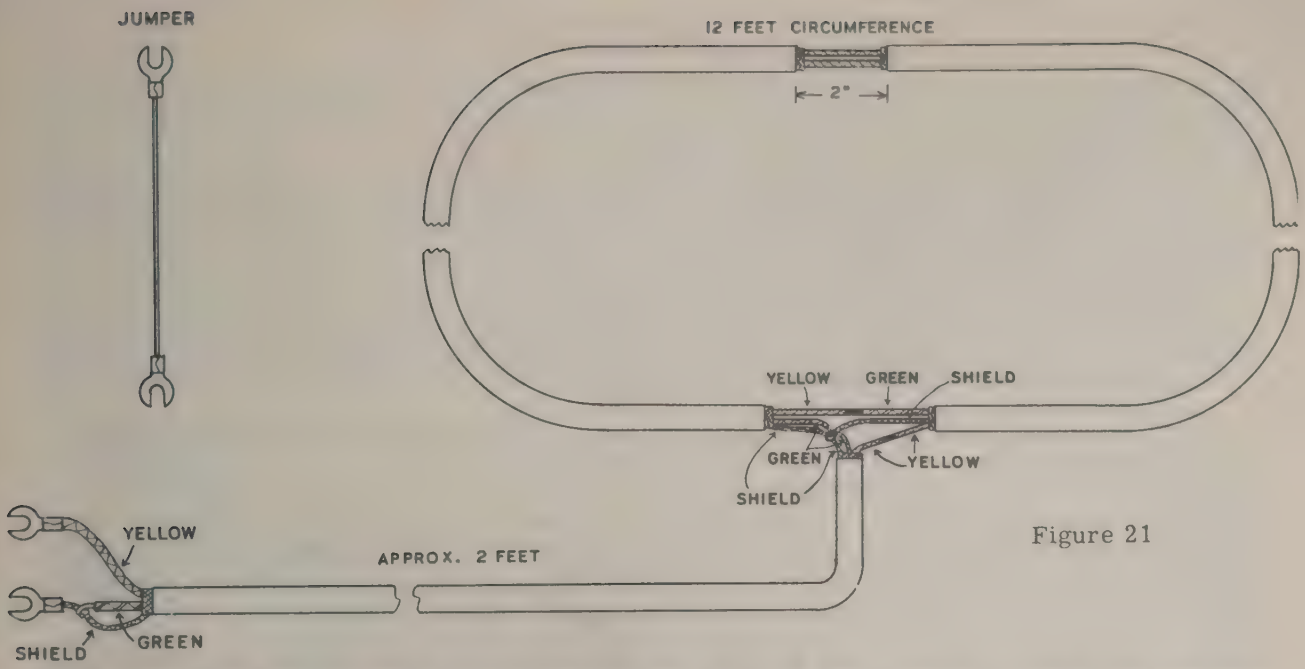



Figure 21

( ) Measure half-way around the loop now formed (six feet from either end) and make two cuts around the outer insulation, approximately 2" apart. Slit the insulation lengthwise between the two cuts and peel the outer insulation away. Cut away the shield braid, taking care not to cut the insulation of the two inner conductors. Remove all of the braid at this point so there will be no possibility of contact across the 2" gap. Wrap with tape if desired.

( ) Prepare the remaining short length of 2-conductor cable as follows: Cut away 1 1/2" of outer insulation at each end of the cable and unwind the shield wire as before, twisting both ends to form pigtails. Strip about 1/4" of insulation from all four ends of the inner conductors. At one end, connect the yellow wire to the free yellow wire on the loop and solder. Wrap with tape to insulate the connection. Also connect the green wire to the free green wire appearing at the opposite end of the loop but do not solder yet. Twist the braid pigtails at the three cable ends together and then connect the green wires just connected to this junction. Solder the 5-wire assembly carefully, making sure that good contact exists between all wires. The entire junction may be wrapped with tape to improve the appearance if desired.

( ) At the opposite end of the short cable, cut the braid pigtail so that it is the same length as the two wires. Connect the green wire to the braid about 1/4" from the end of the braid and solder. Install a spade lug on the end of the braid and a lug on the end of the yellow wire and solder securely. A good connection will be assured if the tabs on the spade lugs are bent over the wire tightly before soldering.

( ) Cut a bare wire to a length of 2" and solder a spade lug on each end. This completes construction of all antenna parts.

IMPORTANT WARNING: MINIATURE TUBES CAN BE EASILY DAMAGED WHEN INSTALLING THEM IN THEIR SOCKETS. THEREFORE, USE EXTREME CARE WHEN INSTALLING THESE TUBES. WE DO NOT GUARANTEE OR REPLACE MINIATURE TUBES BROKEN DURING INSTALLATION.

( ) Insert a 6BA6 tube in socket B, a 6BE6 at C, a 6BA6 at D and a 12AU7 at E. Do not install the 6X4 tube in socket A yet. Place the #47 bulb in the pilot lamp socket.

This completes construction of the tuner. The unit should now be tested before the front panel and top and bottom covers are installed.

## TESTING THE COMPLETED TUNER

Before connecting the receiver to the AC outlet, check the following points:

1. Be sure the 6X4 rectifier is not in its socket.
2. If an ohmmeter is available, check the DC resistance from terminal strip E2 to ground. The reading should be approximately 40,000 Ω after 15 seconds. If considerably lower, carefully recheck the wiring for an error or short circuit. If everything appears to be all right, try removing the tubes one at a time to see if the short will disappear. If it does, the tube may be shorted or an error may exist at the tube socket. If this procedure fails to help, it will be necessary to disconnect the high voltage wires on at a time until the short circuit disappears to isolate the source of trouble. Resistance readings considerably higher than 40,000 Ω will indicate an open circuit between E2 and pin 6 of the 6BA6 tubes or between pin 6 and ground.
3. Be sure the switch is off by rotating the VOLUME control to its full counterclockwise position.

Connect the line cord to a 110-125 volt 50-60 cycle AC outlet. DO NOT CONNECT THE TUNER TO A DC (DIRECT CURRENT) LINE. SERIOUS DAMAGE TO THE POWER TRANSFORMER WILL RESULT. No attempt should be made to use this unit on 25 cycle AC lines, since the transformer may be seriously damaged and the receiver will not operate.

Turn the receiver on by rotating the VOLUME control clockwise until a click is heard. The filaments of the two 6BA6's, the 6BE6 and the 12AU7 should show a red color and the pilot lamp should light. Now insert the 6X4 rectifier tube in socket A. This tube should also show filament color. If the 6X4 plates show a red color or if the tube shows a bright violet glow internally, turn the tuner off immediately and recheck the wiring for an error. Any such action indicates that excessive current is being drawn from the power supply.

High current can be caused by errors or shorts in the wiring or by defective components. The procedure described under Step 2 above will help locate the source of difficulty.

NOTE: The tubes in the tuner normally become quite hot due to the relatively large amount of current drawn through them. This characteristic is typical of all tubes where the plate current is relatively high and does not indicate that anything is wrong with the tuner.

Connect one end of the audio cable previously prepared to the output nearest the antenna terminals at the rear of the tuner. Connect the opposite end to the input of the amplifier or preamplifier to be used. Advance the VOLUME control to the full clockwise position. A fairly loud "hiss" should be heard from the speaker system. If the VOLUME control has no effect on the level of the noise, the capacitors connected to the two output connectors may have been accidentally interchanged. Corrective measures are not necessary. Connect the cable to the outside audio output instead. Rotate the TUNING control over its entire range. Strong local AM stations should be heard. If the receiver will operate in this manner, it may be assumed that it is operating properly. In case of improper performance, follow the procedures outlined under IN CASE OF DIFFICULTY.

## ALIGNMENT OF THE TUNER

After alignment is completed, or if it is intended that the tuner be aligned at a later date, it is suggested that the alignment tool be taped to the inside surface of the back panel near the bottom so that it will not be misplaced. Masking tape, transparent tape or even adhesive tape will do. The tool is not generally useful since it is designed for a specific type of IF transformer.

Although the IF transformers and other coils have been calibrated at the factory, the tuning capacitor trimmers have not, this being impossible with separately mounted coils. Therefore, the trimmers must be adjusted to bring the tuner into calibration. The procedure is simple and can be accomplished quickly as follows. If a signal generator and vacuum tube voltmeter are not available, it will be necessary to install the loop antenna as indicated under INSTALLATION on Page 35 of this manual.

Tune in a station of known frequency as near 1400 kc as possible. Note the dial reading on the tuner. If it reads lower than the actual station frequency, it will be necessary to tighten the oscillator trimmer. If it reads high, the trimmer should be loosened. Start alignment by tuning in the station, then set the dial closer to the correct calibration point on the dial, keeping the station tuned well enough to be audible. Adjust the oscillator trimmer shown in Figure 13, tightening or loosening it as indicated above to bring the station in clearly once again. Repeat the procedure until the station comes in at the correct calibration point on the dial. Next, adjust the mixer trimmer for maximum clear sound, then the antenna trimmer. Rock the dial back and forth once or twice to make sure the oscillator frequency has not shifted. Readjust the oscillator trimmer if necessary. While adjustment using this method may not be perfect, it should be satisfactory, since a broadband tuner is less critical than a sharply tuned type.

If a signal generator and VTVM are used, the procedure will be modified somewhat. A 10 KΩ resistor should be left over after construction of the kit is completed. In a temporary fashion, solder this resistor between input IF transformer lugs Q3 and Q4. This will load the primary of the transformer to such an extent that the stage becomes impedance-coupled and will give a single peaked response for alignment purposes. Alignment with a VTVM indicating output from a wideband IF system is impractical, since indications will be approximately the same over a spread of 19 kc, making it impossible to find the proper peak response. Connect the VTVM or 20,000 Ω per volt meter between terminal strip T3 and ground and set the meter for a negative voltage indication. With no antenna connected, connect the signal generator output leads across the two outside terminals on the antenna strip, the ground lead to the ground screw, and the "hot" lead through a .01 μfd capacitor to the other screw. Set the generator frequency to 1600 kc and the receiver dial to the same frequency. Adjust the oscillator screw for maximum indication, reducing or increasing the generator output as necessary to produce a voltage reading of approximately 4 volts. (NOTE: If the voltage appears positive instead of negative in polarity, the detector diodes have been installed backwards and it will be necessary to reverse both of them.) Next, set both the generator and tuner dials to 1400 kc and rock the tuner dial to obtain maximum indication. Peak the mixer trimmer and then the antenna trimmer, rocking the receiver dial while adjusting the screw to get the best possible peak sensitivity. Keep the generator output at a level that will produce about 4 volts of AVC. This will complete adjustment of the front end. BE SURE TO REMOVE THE 10 KΩ RESISTOR connected from Q3 to Q4 after adjustments are completed.

Alignment of the IF transformers and the RF coils should not be attempted unless there is some evidence of mistracking or poor alignment, due to the critical nature of the alignment procedure. If it should be desired to align the entire tuner, the following procedure should be used.

Observe the alignment tool furnished with the kit carefully. Note that the two ends are different, one having a shoulder to limit the insertion travel of the tool and the other end having a small diameter shank behind the haxagonal drive. The end with the small diameter shank may be used to align each of the slugs in each transformer from one end of the transformer but this is not recommended unless the operator is thoroughly familiar with alignment procedures. Possibility of misalignment will be avoided by using the end with a shoulder at the top and bottom of each transformer, since it is impossible to turn both slugs at once with this end.

Reference to the top slug indicates that the adjustment is made on the core nearest the back of the tuner. The bottom slug is the core nearest the chassis.

For safety, the tuner should be turned off when signal generator lead changes are made, since high voltage is present at many points creating a possibly dangerous shock hazard when working in close quarters. Terminal strip S1 should be carefully avoided for there is about 250 volts present at this point.

Adjustment of the IF stages must be accomplished first, since the RF and oscillator stages are always tracked to the IF frequency. Connect a VTVM or 20,000 Ω per volt meter from terminal strip T3 to ground (chassis), setting the meter for indications near 4 volts at negative polarity.

Set the signal generator to 455 kc and connect the ground lead to a convenient point on the chassis. The "hot" output lead of the generator should be connected to 6BA6 tube socket D1 through a .01 μfd capacitor. Using the alignment tool furnished with the kit, adjust the top slug of output IF transformer R for maximum indication, adjusting generator output as necessary to maintain an indication as near 4 volts as possible. If generator output is low and it is not possible to obtain 4 volts of AVC, use the maximum obtainable voltage. Next, adjust the bottom slug of transformer R for maximum indication. This completes adjustment of transformer R.

Turn the tuner off and connect the 10 KΩ resistor furnished with the kit between input IF transformer Q1 and Q2, soldering it in a temporary fashion. Connect the signal generator ground lead to chassis and the output lead through a .01 μfd capacitor to 6BE6 socket C7. Turn the set on and adjust the top slug of IF transformer Q for maximum indication. Turn the tuner off again and remove the 10 KΩ resistor from Q1 and Q2, reconnecting it between Q3 and Q4, in a temporary manner. Turn the tuner on and adjust the bottom slug for maximum indication, keeping this indication near 4 volts. This completes adjustment of the IF system. DO NOT REMOVE THE 10 KΩ RESISTOR at this time unless there is no intention of tracking the RF coils at the low end of the broadcast band. Make SURE that the resistor is removed after all alignment is completed.

To adjust the RF end of the receiver, leave the meter connected at the same point but connect the signal generator ground to chassis and the signal lead to the stator of the rear tuning capacitor section Z5, through a .01 μfd capacitor. Set the generator and receiver dials to 1600 kc and adjust the oscillator trimmer for maximum indication. Next, set both dials to 1400 kc and rock the tuner dial to find the maximum response, then adjust the mixer trimmer for maximum indication. After this adjustment is completed, set both dials to 600 kc and adjust the oscillator coil slug K from the rear of the tuner for a peak, and then the mixer coil slug L for peak. Slug L can be reached through one of the cooling slots in the rear panel. Repeat this procedure as many times as necessary until no improvement can be obtained and the oscillator tracks properly with the dial calibration. When repeating top and bottom calibration adjustment, rock the receiver dial for maximum response before adjusting the mixer coil and trimmer. Oscillator coil adjustments should be repeated only often enough to bring the receiver into proper calibration. The mixer is then tracked to the oscillator.

To complete RF alighment, change the signal generator connections to the two outside antenna terminals, with ground to the ground terminal and the hot lead of the generator connected to the hi-Z antenna input through a .01 μfd capacitor. Set the receiver and generator dials to 1400 kc tuning the receiver for maximum indication. Adjust the antenna trimmer for peak response. Now, tune both units to 600 kc, rock the receiver for peak indication and adjust antenna coil slug J for peak, turning the screw from the front of the tuner. Repeat these operations as often as necessary until no improvement can be obtained. NOW, BE SURE TO REMOVE THE 10 KΩ RESISTOR CONNECTED FROM Q3 TO Q4. Alignment of the tuner is now complete, except for adjustment of the 10 kc whistle filter coil.

## ADJUSTMENT OF THE WHISTLE FILTER COIL

In order to obtain maximum suppression of the ever-present 10 kc beat note caused by heterodyning of adjacent channel carriers, careful adjustment of the filter coil is necessary. The adjustment screw for coil W can be reached through a hole provided in the dial plate in front of the tuner. Fair results can usually be obtained by connecting the antenna to the tuner as described under INSTALLATION and tuning to some point at the high end of the band where a number of stations are present. Tune the receiver so that it is between two stations on adjacent channels. This should produce a strong 10 kc whistle. The whistle can be heard clearly if the treble boost control on the amplifier is turned all of the way up. Adjust the filter slug for minimum audible response. If at all possible, an AC meter connected across the output lead of the tuner should be used, since the meter is much more sensitive than the ear at high frequencies. Of course, the adjustment would be made for minimum indication on the AC meter, assuming that the indication is largely caused by the 10 kc note, not the modulation of the two stations being used. An oscilloscope can also be used, making it easier to identify the 10 kc note.

Another satisfactory method of tuning the filter is to connect an accurately calibrated audio oscillator to ground and terminal strip U2, setting the oscillator to 10 kc. Adjust the screw for minimum output.

The final touch up for perfection can be accomplished by setting the tuner on its bottom plate and adjusting the coil once again. It is not necessary to fasten the plate in place with the screws for this adjustment. Finishing adjustments in this manner will set the coil closer to normal operating conditions encountered when the tuner is installed in its metal cabinet.

## FINAL ASSEMBLY OF THE TUNER

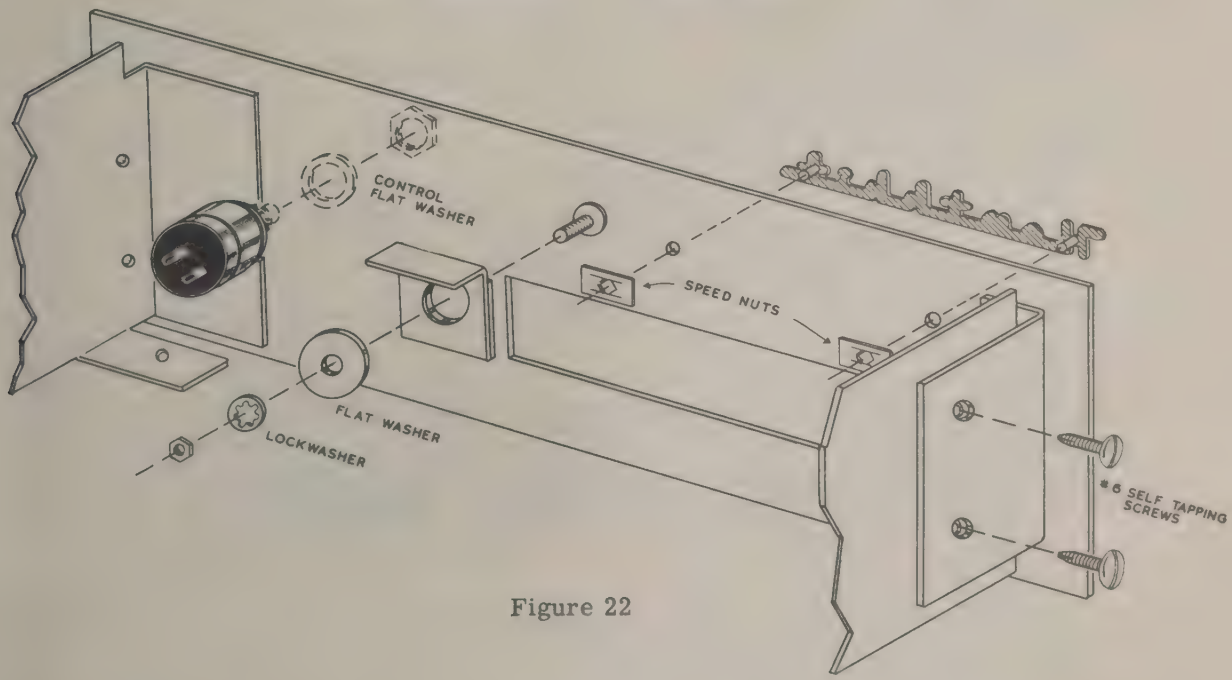



Figure 22

( ) Place the panel reinforcing bracket over the stud at the center of the front panel, as shown in Figure 22. The stud goes through the bracket, a large 9/16" flat metal washer, a lockwasher and nut. Tighten in place with the bracket flange slightly below and parallel with the top of the panel.

( ) Mount the HEATHKIT nameplate on the front panel. Insert the pins through the small holes in the upper left corner of the panel. Push a spring steel speednut down over each pin from the back of the panel. The long side of each speednut must be parallel with the top of the panel. Cut off excess length of each pin.

( ) Make sure the tuner is disconnected from the power outlet and remove the nut holding the VOLUME control in place on the right bracket. Hold the control firmly in place and slip the right hand opening in the panel over the control shaft. Place the control flat washer over the shaft and secure with the nut. Do not tighten yet.

( ) At the left end, secure the panel with a 6-32 self-tapping screw through each elongated hole in the front panel bracket, after lining these holes up with the ones in the left chassis bracket. Leave the screws slightly loose.

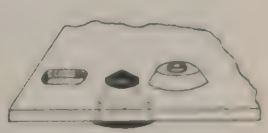


Figure 23

( ) Observe Figure 23 and install the four rubber feet in the four large holes provided in the bottom cover. Insert from the painted side of the cover.

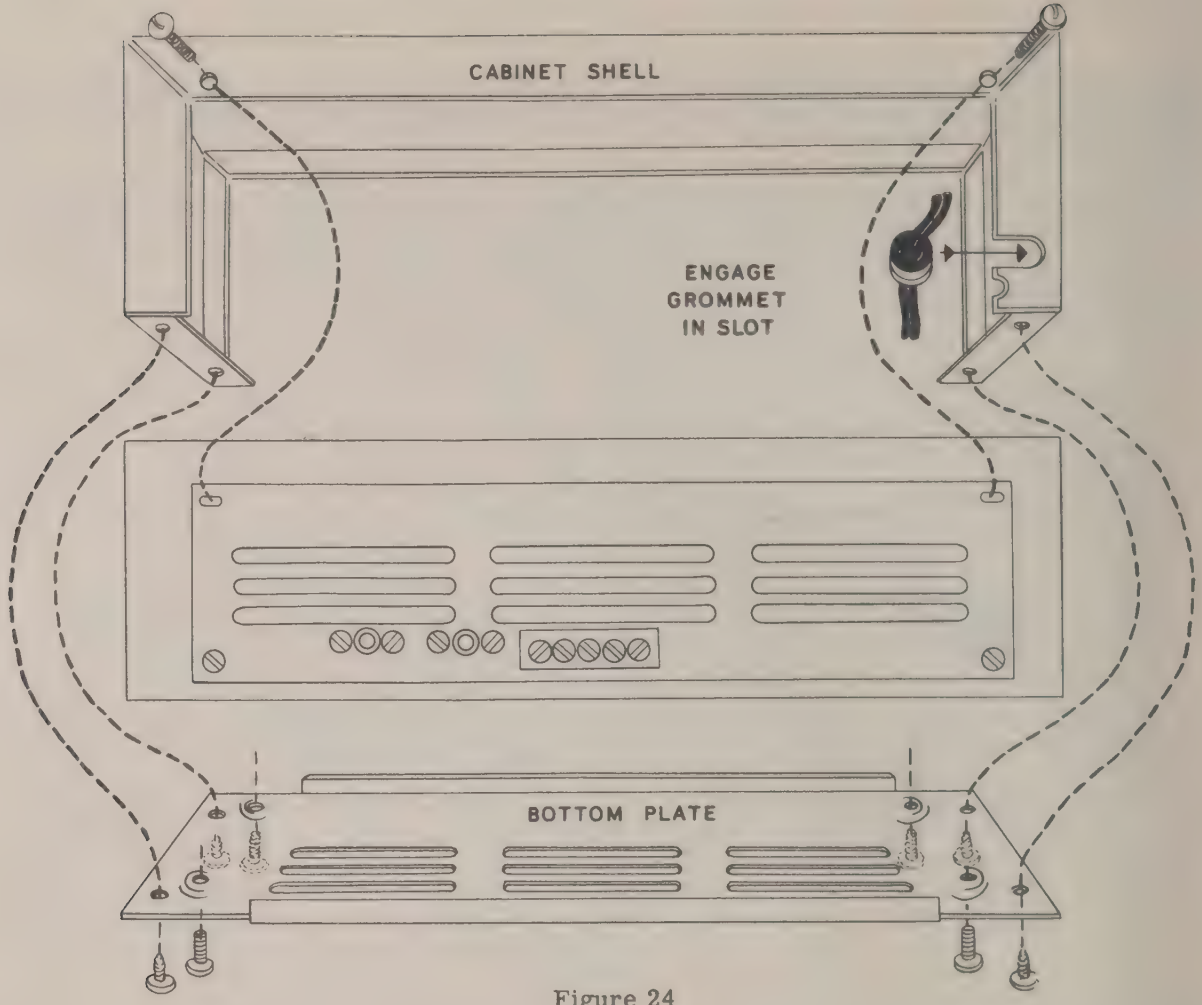



Figure 24

( ) With the cooling vents to the rear, install the bottom cover as shown in Figure 24, using 6-32 self-tapping screws at each dimpled opening.

( ) Align the bottom cover so that the bottom edge is just flush with the bottom edge of the panel and tighten the control nut and the self-tapping screws at the left end. Inspect the assembly from the top to make sure none of the electrical components mounted on the chassis are touching the bottom cover.

( ) Slip the knobs on the control shafts. The knobs push on the flatted shafts, after proper alignment between the flat and the spring insert in the knob. If necessary, loosing the volume control nut to secure proper relationship between the knob indicator line and the panel markings. Then retighten the nut.

( ) Install the top cover. Before sliding in place, engage the free grommet previously installed on the line cord in the slot provided at one end of the cover. Engage the front lip of the cover with the panel clamp as shown in Figures 22 and 24 and let the cover down until the bottom flanges rest on the bottom cover. Fasten in place by inserting two 6-32 self-tapping screws through the two small holes in top rear flange of the shell. These screws will pass through slots in the rear panel and thread into the end brackets.

( ) Turn the tuner upside down and fasten the top shell to the bottom cover with #6 sheet metal screws through each of the four elongated slots provided. Before tightening the sheet metal screws, make sure the top shell sides are parallel with the edges of the front panel. If necessary, adjust the cover and tighten the screws. The tuner is now ready to place in service.

## IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the pictorial as it is followed in the receiver. Most cases of difficulty result from wrong connections or poorly soldered joints. Often having a friend check the wiring will reveal a mistake consistently overlooked.
2. If possible, compare tube socket voltages with those shown in the table. The readings should be within 20% of those tabulated if a vacuum tube voltmeter is used. Other type meters may give lower readings, due to loading effects. If the voltage fails to compare with the value shown, check further into the circuit involved by checking the various components (resistors, capacitors, tubes, etc.).

| SOCKET TUBE TYPE | Pin 1 | Pin 2 | Pin 3 | Pin 4 | Pin 5 | Pin 6 | Pin 7 | Pin 8 | Pin 9 |
|---|---|---|---|---|---|---|---|---|---|
| A 6X4 | 190-230 AC | NC | 0 | 6.3 AC | NC | 190-230 AC | 250 | | |
| B 6BA6 | *0.5-1 Neg. | 0 | 6.3 AC | 0 | 220 | 80 | 0.6 | | |
| C 6BE6 | *10 Neg. | 0 | 6.3 AC | 0 | 190 | 85 | 0.5-1 Neg. | | |
| D 6BA6 | *0.2-0.4 Neg. | 0 | 6.3 AC | 0 | 190 | 75 | 0.6 | | |
| E 12AU7 | 75 | 0 | 3.3 | 6.3 AC | 6.3 AC | 145 | 43 | 75 | 0 |

All readings taken with a Heathkit Vacuum Tube Voltmeter. All readings are DC voltages measured to chassis, unless otherwise specified. The antenna must be disconnected and the dial set to 1600 kc.
NC - no external connection to this contact.
Line voltage - 115 volts 60 cycles.
*Socket voltages at pin 1 of the 6BA6's and pin 7 of the 6BE6 are subject to wide variation, since these pins are connected to the AVC line. With no antenna and no station tuned in, the voltage should be somewhere near the value specified in the chart. A strong negative voltage will be indicative of oscillation and the instructions under OSCILLATION which follow should be checked. A strong positive voltage will either indicate that the crystal diodes have been installed backward, or some of the B+ voltage from the power supply is finding its way to the AVC line through some error in wiring or a defective component.

Some common types of troubles are listed below, along with simple trouble-shooting procedures which are often helpful in locating the source of difficulty.

TUNER COMPLETELY INOPERATIVE: If no sound of any kind is evident when the VOLUME control is turned fully clockwise with the output connected to an amplifier and an antenna connected to the input, check the 6X4 rectifier tube visually once again to be sure that the plates are not red. When sure that everything is all right at this point, check the interconnecting audio cable for short circuits between the shell of the plug and the inner conductor at both ends (an ohmmeter check is recommended) and make sure the connection is secure at both ends.

In some cases, the tuner will operate out of its metal cabinet and be dead when installed. A short circuit of some type is obvious, the most troublesome one usually occuring at the volume control. With top cover off, check to see that the bottom cover mounting screw does not touch any of the lugs on the volume control. If a short exists at this point, all audio output will be cut off. The simplest remedy is to bend the troublesome control lug up slightly. Another source of trouble may be pins 1, 2 or 3 of 6BA6 tube B or pins 1, 2 or 3 of 12AU7 tube E, where the pins and the components connected to them are very close to the bottom cover. Redress of components and bending of socket pins should alleviate the difficulty.

A high voltage short could occur if terminal strip S should bend outward so that the lugs extend beyond the edge of the chassis. Make sure this strip is bent at a $90^{O}$ angle to the chassis, or slightly inward.

A screwdriver is a useful tool for making simple disturbance tests. If a stage in the tuner is operating normally, a sound will be heard in the speaker when the grid of an operating stage is touched by the metal part of the screwdriver. This procedure should be started at the 12AU7 stage with the VOLUME control turned fully clockwise. Touch the screwdriver to pin 7 of socket E. A click or hum should be heard in the speaker. If not, check the cathode follower output stage wiring once again. If the wiring appears to be correct, check the tube and the audio cable. Check the .05 $\mu$fd capacitors connected to the two output jacks to make sure they are not shorted or open. Pin 2 of socket E should be touched next. The response should be louder than when pin 7 was checked. If not, repeat the checks mentioned above.

When everything is operating normally in the 12AU7 stage, the detector should be checked in the same manner, touching terminal strips U2, T3 and T1 in this sequence. Loss of signal at one of these points will indicate a shorted or open capacitor or a wiring short circuit at one of the strips. Next, touch pins 1 and 2 of IF transformer R.

The remaining check points in order are 6BA6 stage D pin 1, 6BE6 stage C pin 7 and 6BA6 stage B pin 1. A gradual increase in response should be noted as the test proceeds toward the input of the tuner. If a point is found where no response is obtained, the defective stage has been isolated and the checking can be concentrated in the area of the stage involved. Response all the way through the tuner but no signal reception may be indicative of serious misalignment of either the IF stages or the tuning coils or capacitor. A review of the alignment procedure previously described is in order in this case. It may be worthwhile to touch the antenna terminals with the screwdriver, for a defect at this point can completely disable the receiver or seriously reduce its sensitivity.

If response can be obtained throughout the receiver but no reception is possible, it is likely that the oscillator may be badly off frequency or not functioning. No negative voltage at pin 1 of the 6BE6 will indicate that the oscillator is not running. If this should be the case, check the 47 $\mu\mu$f capacitor and 22 K$\Omega$ resistor connected to pin 1 of the 6BE6. Measure the oscillator coil with an ohmmeter, if possible, to make sure continuity exists to all three terminals. Inspect all connections and check the tube.

If a signal generator and VTVM are available, the same procedure can be observed by injecting an AM modulated signal at the points indicated above at the appropriate frequency. Response can be heard in the speaker or the VTVM can be used as an indicator by connecting it to ground and terminal strip T3. The use of such instruments is highly recommended, if possible, but the screwdriver disturbance tests will suffice.

OSCILLATION: If the tuner operates but tends to whistle when a station is tuned in, or very low sensitivity is evident, it is possible that the unit is oscillating. A reliable indication is a high negative voltage at T3 when no station is tuned in. Oscillation is usually caused by poor connections or improper lead dress. Shorten all leads as much as possible, dressing them close to the chassis. Resolder any connections about which there may be some doubt. Defective tubes may cause instability and it may be worthwhile to have them checked. If identical types are on hand, try substituting them. Also try exchanging the two 6BA6's in sockets B and D. If possible, check the .005 $\mu$fd and .01 $\mu$fd disc bypass capacitors for an open capacitor will often cause instability.

HUM AND NOISE: Under some conditions, hum may be encountered when the tuner is connected to the audio system. Usually this can be reduced by reversing the direction of the line cord in its receptacle. Hum in the variable output only would indicate the possibility of high heater to cathode leakage in one half of the 12AU7 tube or a circuit short between pin 2 or 3 and pin 4, which has 6 volts of 60 cycle AC for the filament circuit on it. Hum in both outputs may indicate the same thing, the trouble being in the first half of the 12AU7.

If the volume control has no effect on the hum, the trouble will be in the 12AU7 stage, but if it attenuates the hum, the source may lie elsewhere in the tuner. In this case, try removing tubes B, C, and D in order and one at a time to see if the noise disappears. If the hum vanishes when one of these tubes is removed, the trouble is isolated to the particular stage involved. A common source of hum troubles is poor ground connections. Carefully tighten all ground lugs and terminal strips and resolder any connections that look suspicious.

A certain amount of noise is normal when the receiver is being tuned between stations. This noise should disappear or quiet down substantially when a station is tuned in, depending on the signal strength. Failure to quiet properly may indicate improper alignment or a poor antenna installation if the tuner is operated in a locality far distant from any AM station. The loop antenna is directional and should be located and oriented for best performance from the weakest station you wish to listen to.

Oscillation can cause excessive noise in the receiver, as can a defective tube. Also, the antenna will pick up some noise but this can be reduced by placing the loop or straight wire in a location away from power lines and outlets on the floor or wall and well away from other electrical appliances, especially television sets.

Squeals and squalls all over the band at different pitches are usually caused by the horizontal oscillator in a nearby television set. This oscillator produces a waveform essentially a sawtooth in shape, which has an extremely high harmonic content. Since this waveform is inductively coupled to the horizontal oscillator transformer, electromagnetic radiation of the 15 kc sweep and its harmonics will exist. Although most TV sets are carefully shielded to suppress this radiation, perfect high frequency attenuation is rarely achieved. Therefore, the harmonics will be picked up by the receiver at frequencies slightly greater than 15 kc apart, causing beats to be heard along with almost every station tuned in. Unfortunately, nothing much can be done about it, the only cure being to turn the TV set off or try to orient the receiver antenna for minimum pickup. It may be worthwhile to try both the loop and the straight wire antennas as described under INSTALLATION, for some improvement may be obtained with one of the two types.

LOW SENSITIVITY: Lack of sensitivity might be traced to improper alignment or to a defective tube. Both should be checked if optimum performance is to be obtained. Also, the loop antenna is directional and should be oriented for best overall results.

## INSTALLATION

The ANTENNA is a very important part of any tuner installation, especially if good reception of weak signals is desired. Two types of antennas can be used with the BC-1 tuner, increasing the installation flexibility.

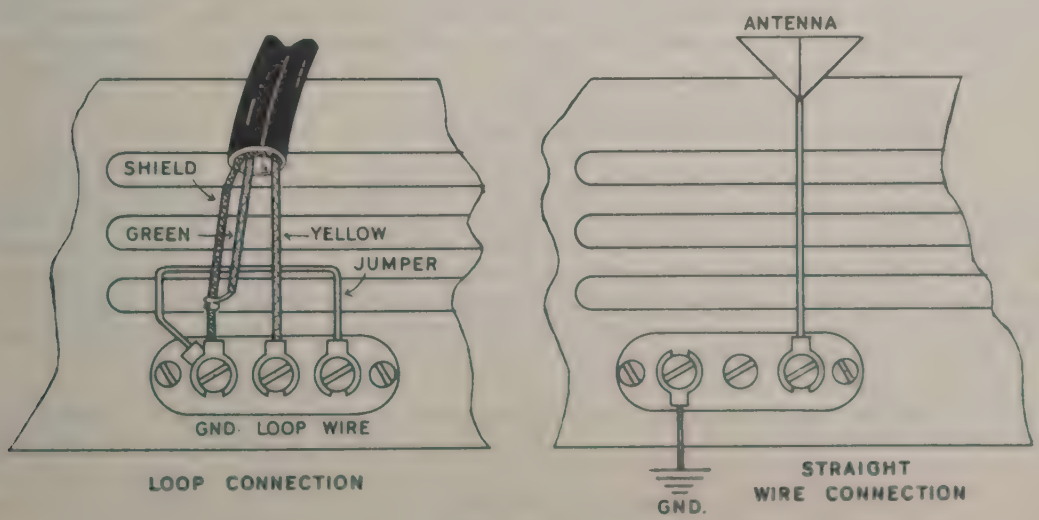



Figure 25

Since the Heathkit BC-1 Tuner was primarily designed around the loop antenna, best performance from a noise standpoint will almost always be obtained with this type. When using the loop, connections should be made as illustrated in Figure 25 on Page 35. Best results will be obtained when the loop is opened as near as possible to a circular or square form and located well away from large metallic objects and house wiring, which can radiate a substantial amount of noise. The loop is kept as small as possibly consistent with good performance so that installation will not be difficult. Good locations are behind a couch, desk, table or behind the high fidelity system cabinet enclosure, if one is used. Keep the loop away from the television set if the set is frequently left turned on while listening to AM programs. Although the loop is broadly directional for signal pickup purposes, it is extremely sharp on the null when fully opened and so cancellation of signals from your favorite station should be avoided. At times this feature can be helpful if an undesired strong signal from a station causes interference with the station tuned, for it is possible to null out or substantially reduce the interference by rotating the antenna for least interference. When reception from strong local stations only is desired, the antenna can be coiled up to a double or triple loop to take up less space and reduce sensitivity to weaker signals, at the same time lessening the possibility of overload from very strong signals. Do not alter the loop itself since performance will be seriously degraded.

In some instances, the straight wire type of antenna may be desirable and this can be installed as shown in Figure 25. For strong station reception only, a short wire from two to eight feet long will probably suffice. This wire can be dropped over the rear of the table or cabinet on which the tuner is placed or run along the baseboard or drapes to keep the wire out of sight. In apartment buildings, it may be necessary to run the wire outside in some manner to avoid noise and signal attenuation. Best performance with weaker signals will be obtained with a long wire outdoor antenna mounted with insulators and well off the ground, bringing signal to the receiver down a wire connected to one end. Lightning arrestors of some type should be used with an outdoor antenna to conform with safety codes.

By all means, experiment to see which antenna will perform best in your locality. No two installations are the same and it is quite likely that a substantial improvement in performance can be obtained by experimenting with antennas.

ADJACENT CHANNEL INTERFERENCE may become a serious problem in localities where reception is "hot" and there are a number of powerful stations nearby. Unfortunately, very wide band receivers such as the BC-1 are susceptible to crosstalk from strong stations at channels adjacent to the station tuned. One possible solution to this difficulty would be to orient the loop antenna for maximum attenuation of the interfering station. The only other alternative is to reduce the bandwidth of the receiver. This is easily accomplished, it is only necessary to connect the 27 KΩ resistor, furnished with the kit, across the primary of the input IF transformer. Connect the resistor from Q3 to Q4. This will load the primary of the transformer heavily, effectively converting the stage from an overcoupled transformer to a single tuned impedance coupled type. A single peaked response similar to that of the output IF transformer will exist and performance will be approximately the same as most conventional good quality AM tuners, except that some improvement in high frequency response will still be evident due to the preemphasis in the audio output stage. Sideband splatter from adjacent stations should be reduced substantially and with only a little sacrifice of audio quality.

PROPER TUNING is essential if full benefit of wide range AM is to be obtained. Mistuning will result in excessive distortion and noise, as well as poor frequency response. If the full IF bandwidth is used, it will be noted that tuning is very broad, with the response remaining much the same over a wide range. Best results are obtained by tuning midway between the points where reception drops off sharply. On weaker stations, tune for the quietest performance point, or tune for best wide range sound. In cases where the bandwidth has been reduced, simply tune for maximum loudness, the same as with any other radio.

TWO OUTPUTS are provided on rear panel of the tuner for maximum flexibility of installation. If wired correctly, the output near the antenna terminals is the variable level output, controlled by the volume control. This output should be used if it is desired to control audio level at the tuner or if the amplifier used with tuner is located in a remote place. This is a cathode follower output which allows long lines to be used without serious loss of high frequencies.

If the tuner is to be used with a separate preamplifier such as the Heathkit WA-P2 and will be located close to the control unit, it may be preferable to use the outer output, which is fixed level taken directly from the output of the 10 kc whistle filter. Since the output is constant, it is more convenient to operate the preamplifier controls, the output level always being the same for a given station. This will prevent annoying blasting encountered if the volume control of the tuner is accidentally turned up too far when it is turned on.

The variable output may also be used with the preamplifier. For best results, the volume or input level controls on the preamplifier should be set at low level and the volume control of the tuner used in its mid-range position. Any residual noise that may be present in the 12AU7 audio stage will be kept at a minimum in this manner.

A common misunderstanding seems to prevail regarding impedance matching in high fidelity installations. In general, exact matching is required only in the case of power output types of devices, such as a high fidelity power amplifier and its associated speaker system, or a line amplifier to the transmission line and its termination. Most of the other components of the system have medium low or low impedance outputs in the order of 600 Ω to approximately 50 KΩ taken from cathode followers or heavily loaded voltage amplifiers, both types being used in the Heathkit BC-1 Tuner. These outputs are usually wired to produce voltage, not power, at low impedance and so matching is not required and in most cases is undesirable. The Heathkit BC-1, as well as most other audio source equipment, is designed to operate into a load of 100 KΩ or higher. Best performance will be obtained working into an input impedance or resistance of 500 KΩ or 1 megohm.

In general, the Heathkit BC-1 Tuner may be used with any type of transformer operated amplifier which has provision for a crystal phonograph pickup or tuner. Simply connect the audio cable to the appropriate input. If no such input is provided on the unit to be used, most radio servicemen can install one for a reasonable fee.

DO NOT CONNECT THE TUNER TO ANY AC-DC EQUIPMENT. The entire tuner cabinet and panel are connected to circuit ground and connection to AC-DC equipment will make the tuner hot to one side of the AC line, an extremely dangerous situation. Fatal shock could result. AC-DC amplifiers can be used only when the input is safely isolated from the AC line.

Sufficient signal exists at either output to drive high impedance earphones of the magnetic or crystal type. This makes it possible to listen to favorite late hour programs without disturbing others. Also, AM-FM binaural broadcasts can be enjoyed using the BC-1 to drive one earphone and an FM tuner such as the Heathkit FM-3 to drive the other.

HEAT DISSIPATION in the tuner is adequately taken care of through the ventilating slots in the top, back and bottom covers. The rubber feet lift the tuner high enough off the mounting surface to allow air circulation underneath. When installing the tuner, make sure none of the ventilating cutouts are blocked off.

The BC-1 will become quite warm after it has been in operation for a fairly long period of time. This is especially true when the tuner is installed in an abnormally warm location. All components in the tuner are adequately rated to handle this heat without danger of breakdown but there is a chance that the finish on fine wood furniture may be damaged unless certain precautions are observed. In some cases, the temperature beneath the tuner may reach as high as 120° F. and it is possible that very delicate finishes could be blistered by this heat. If there is reason to doubt the ability of the surface to withstand heat, it may be advisable to put some kind of insulating material between the tuner and the surface. A cloth doily, cardboard or thin asbestos pad should be sufficient. It is extremely unlikely that the heat would damage glass, leather or plastic surfaces and most finished woods will withstand the heat without damage. Some types of finishes are more delicate than others, however, and a little care taken during installation may avoid unhappiness later.

The tuner is primarily designed to sit out in the open and it is for this reason that careful attention has been given to the physical appearance. If the tuner is to be mounted in a cabinet of some type, make sure the back of the enclosure is open and the space large enough to allow unrestricted air circulation. If the available space is small or air circulation is poor, it is recommended that the top and bottom covers be left off to aid cooling. Avoid this situation if possible, since removal of the covers will probably increase the noise picked up by the tuner. Excessive heating of components in the tuner will lead to premature failure.

Mounting the tuner on end with the knobs in a vertical plane is not recommended, for radiated heat from the tubes is trapped by the IF transformers, causing overheating. If it is desired to mount the tuner on its back in a horizontal panel arrangement, it will be necessary to leave the top and bottom covers off to avoid trapping heat on the circuit side of the chassis. Good ventilation in the cabinet is essential if this mode of operation is employed. The panel should be elevated about 1/8" or more above the cabinet panel to allow a circulation path directly around the tuner. This can be accomplished by placing rubber grommets or wood spacers between the two panels.

In all cases where the tuner is operated without the top and bottom covers, some provision should be made so that it will be impossible for small children or pets to get at the back of the unit. High voltages in the circuit are exposed and they can cause severe injury to anyone coming in contact with them.

## REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty tube or component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information:

A. Thoroughly identify the part in question by using the part number and description found in the manual parts list.
B. Identify the type and model number of kit in which it is used.
C. Mention the order number and date of purchase.
D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. Please do not return the original component until specifically requested to do so. Do not dismantle the component in question as this will void the guarantee. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

## SERVICE

In event continued operational difficulties of the completed instrument are experienced, the facilities of the Heath Company Service Department are at your disposal. Your instrument may be returned for inspection and repair for a service charge of $5.00 plus the cost of any additional material that may be required. THIS SERVICE POLICY APPLIES ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned not repaired.

The Heath Company is willing to offer its full cooperation to assist you in obtaining the specified performance level in your instrument. Factory repair service is available for a period of one year from the date of purchase or you may contact the Engineering Consultation Department by mail. For information regarding possible modification of existing kits, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at any electronic outlet store.

Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for specific purposes. Therefore, such modifications must be made at the discretion of the kit builder according to information which will be much more readily available from some local source.

## SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted. Attach a tag to the instrument giving name, address and trouble experienced. Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

## SPECIFICATIONS

All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

## WARRANTY

The Heath Company limits its warranty of parts supplied with any kit to a period of three (3) months from the date of purchase. Replacement will be made only when said part is returned postpaid, with prior permission and in the judgment of the Heath Company was defective at the time of sale. This warranty does not extend to any Heathkits which have been subjected to misuse, neglect, accident and improper installation or applications. Material supplied with a kit shall not be considered as defective, even though not in exact accordance with specifications, if it substantially fulfills performance requirements. This warranty is not transferable and applies only to the original purchaser. This warranty is in lieu of all other warranties and the Heath Company neither assumes nor authorizes any other person to assume for them any other liability in connection with the sale of Heathkits.

The assembler is urged to follow the instructions exactly as provided. The Heath Company assumes no responsibility or liability for any damages or injuries sustained in the assembly of the device or in the operation of the completed instrument.

HEATH COMPANY
Benton Harbor, Michigan

| PART No. | PARTS Per Kit | DESCRIPTION |
|---|---|---|
| **Resistors** | | |
| 1-2 | 2 | 68 Ω |
| 1-6 | 1 | 470 Ω |
| 1-20 | 1 | 10 KΩ |
| 1-22 | 1 | 22 KΩ |
| 1-23 | 1 | 27 KΩ |
| 1-24 | 1 | 33 KΩ |
| 1-25 | 4 | 47 KΩ |
| 1-26 | 1 | 100 KΩ |
| 1-35 | 4 | 1 megohm |
| 1-37 | 2 | 2.2 megohm |
| 1-38 | 1 | 3.3 megohm |
| 1-44 | 4 | 2.2 KΩ |
| 1-102 | 1 | 82 KΩ |
| 1-9A | 1 | 10 KΩ 1 watt |
| 1-26A | 1 | 15 KΩ 1 watt |
| 1-27A | 2 | 33 KΩ 1 watt |
| 1-15B | 1 | 1000 Ω 2 watt |
| **Capacitors** | | |
| 21-3 | 1 | 10 μμf disc |
| 21-9 | 2 | 100 μμf disc |
| 21-11 | 1 | 150 μμf disc |
| 21-16 | 6 | .01 μfd disc |
| 21-17 | 1 | 270 μμf disc |
| 21-27 | 5 | .005 μfd disc |
| 21-32 | 3 | 47 μμf disc |
| 21-36 | 2 | .002 μfd disc |
| 23-61 | 4 | .05 μfd tubular |
| 25-16 | 1 | 20 μfd 350 volt electrolytic |
| 25-30 | 1 | 20-20 μfd 350 volt electrolytic |
| 26-33 | 1 | 3-gang tuning |
| **Control-Dial Parts-Knobs** | | |
| 19-27 | 1 | 1 megohm control w/switch |
| 100-M70 | 1 | Tuning drum |
| 100-M80 | 1 | Dial plate assembly |
| 100-M85 | 1 | Dial cord assembly |
| 253-28 | 3 | Plastic "O" washer |
| 258-1 | 1 | Dial cord spring |
| 453-19 | 1 | Drive shaft |
| 455-6 | 1 | Shaft bushing |
| 462-28 | 2 | Knob |
| 463-10 | 1 | Dial pointer |
| **Sockets-Plugs-Terminal Strips** | | |
| 431-2 | 1 | 2-lug terminal strip |
| 431-3 | 2 | 3-lug terminal strip |
| 431-8 | 1 | 3-lug screw-type strip |
| 431-10 | 2 | 3-lug terminal strip |
| 431-12 | 1 | 4-lug terminal strip |
| 431-14 | 1 | 2-lug terminal strip |
| 434-16 | 1 | 9-pin tube socket |
| 434-37 | 4 | 7-pin tube socket |
| 434-42 | 2 | Phono connector socket |
| 434-44 | 1 | Pilot lamp socket |
| 438-4 | 2 | Phono plug |
| **Coils-Transformers** | | |
| 40-87 | 1 | Antenna coil |
| 40-88 | 1 | Mixer coil |
| 40-89 | 1 | Oscillator coil |
| 40-90 | 1 | Whistle filter coil |
| 52-8 | 1 | Input IF transformer |
| 52-9 | 1 | Output IF transformer |
| 54-34 | 1 | Power transformer |

| PART No. | PARTS Per Kit | DESCRIPTION |
|---|---|---|
| **Wire-Cable-Sleeving** | | |
| 89-1 | 1 | Line cord |
| 340-2 | 1 | length Bare wire |
| 343-2 | 1 | length Shielded cable |
| 344-1 | 1 | length Hookup wire |
| 346-1 | 1 | length Sleeving |
| 347-3 | 1 | length 2-conductor cable |
| **Tubes-Pilot Lamp-Crystal Diodes** | | |
| 56-4 | 2 | Crystal diode |
| 411-25 | 1 | 12AU7 tube |
| 411-64 | 1 | 6X4 tube |
| 411-90 | 2 | 6BA6 tube |
| 411-91 | 1 | 6BE6 tube |
| 412-1 | 1 | #47 pilot bulb |
| **Grommets-Clips-Tool-Nameplate-Feet** | | |
| 73-1 | 4 | 3/8" rubber grommet |
| 73-4 | 2 | 5/16 rubber grommet |
| 73-6 | 4 | 7/16" rubber grommet |
| 260-7 | 2 | IF transformer clip |
| 261-4 | 4 | Rubber feet |
| 391-1 | 1 | Nameplate |
| 490-1 | 1 | Alignment tool |
| **Hardware** | | |
| 250-2 | 10 | 3-48 x 5/16" screw |
| 250-7 | 2 | 6-32 x 3/16" screw |
| 250-8 | 4 | #6 x 3/8" sheet metal screw |
| 250-9 | 20 | 6-32 x 3/8" screw |
| 250-16 | 1 | 8-32 x 3/16" set screw |
| 250-18 | 2 | 8-32 x 3/8" screw |
| 250-46 | 14 | 6-32 self-tapping screw |
| 251-1 | 1 | 6-32 spade bolt |
| 252-1 | 10 | 3-48 hex nut |
| 252-3 | 21 | 6-32 hex nut |
| 252-4 | 2 | 8-32 hex nut |
| 252-7 | 2 | 3/8-32 control nut |
| 252-16 | 2 | Speed nut |
| 253-10 | 1 | 3/8 nickel washer |
| 253-21 | 5 | 9/16 flat washer |
| 254-1 | 23 | #6 lockwasher |
| 254-2 | 2 | #8 lockwasher |
| 254-4 | 2 | 3/8 control lockwasher |
| 254-7 | 14 | #3 lockwasher |
| 255-2 | 4 | #6 x 3/16" spacer |
| 259-1 | 3 | #6 solder lug |
| 259-6 | 4 | #3 solder lug |
| 259-11 | 4 | #6 spade lug |
| **Sheet Metal Parts** | | |
| 90-M37F | 1 | Cabinet shell |
| 200-M97 | 1 | Chassis |
| 203-76F106 | 1 | Front panel |
| 203-M89F | 1 | Rear panel |
| 204-M90 | 1 | Left end bracket |
| 204-M91 | 1 | Right end bracket |
| 204-M102 | 2 | Capacitor mounting bracket |
| 205-M47F | 1 | Bottom plate |
| 207-M9 | 1 | Panel clamp |
| 595-124 | 1 | Instruction manual |

# HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual through thoroughly to familiarize yourself with the general procedure. Note the relative location of pictorials and pictorial inserts in respect to the progress of the assembly procedure outlined.

This information is offered primarily for the convenience of novice kit builders and will be of definite assistance to those lacking thorough knowledge of good construction practices. Even the advanced electronics enthusiast may benefit by a brief review of this material before proceeding with kit construction. In the majority of cases, failure to observe basic instruction fundamentals is responsible for inability to obtain desired level of performance.

## RECOMMENDED TOOLS

The successful construction of Heathkits does not require the use of specialized equipment and only basic tools are required. A good quality electric soldering iron is essential. The preferred size would be a 100 watt iron with a small tip. The use of long nose pliers and diagonal or side cutting pliers is recommended. A small screw driver will prove adequate and several additional assorted screw drivers will be helpful. Be sure to obtain a good supply of rosin core type radio solder. Never use separate fluxes, paste or acid solder in electronic work.

## ASSEMBLY

In the actual mechanical assembly of components to the chassis and panel, it is important that the procedure shown in the manual be carefully followed. Make sure that tube sockets are properly mounted in respect to keyway or pin numbering location. The same applies to transformer mountings so that the correct transformer color coded wires will be available at the proper chassis opening.

Make it a standard practice to use lock washers under all 6-32 and 8-32 nuts. The only exception being in the use of solder lugs—the necessary locking feature is already incorporated in the design of the solder lugs. A control lock washer should always be used between the control and the chassis to prevent undesirable rotation in the panel. To improve instrument appearance and to prevent possible panel marring use a control flat nickel washer under each control nut.

When installing binding posts that require the use of fiber insulating washers, it is good practice to slip the shoulder washer over the binding post mounting stud before installing the mounting stud in the panel hole provided. Next, install a flat fiber washer and a solder lug under the mounting nut. Be sure that the shoulder washer is properly centered in the panel to prevent possible shorting of the binding post.

## WIRING

When following wiring procedure make the leads as short and direct as possible. In filament wiring requiring the use of a twisted pair of wires allow sufficient slack in the wiring that will permit the twisted pair to be pushed against the chassis as closely as possible thereby affording relative isolation from adjacent parts and wiring.

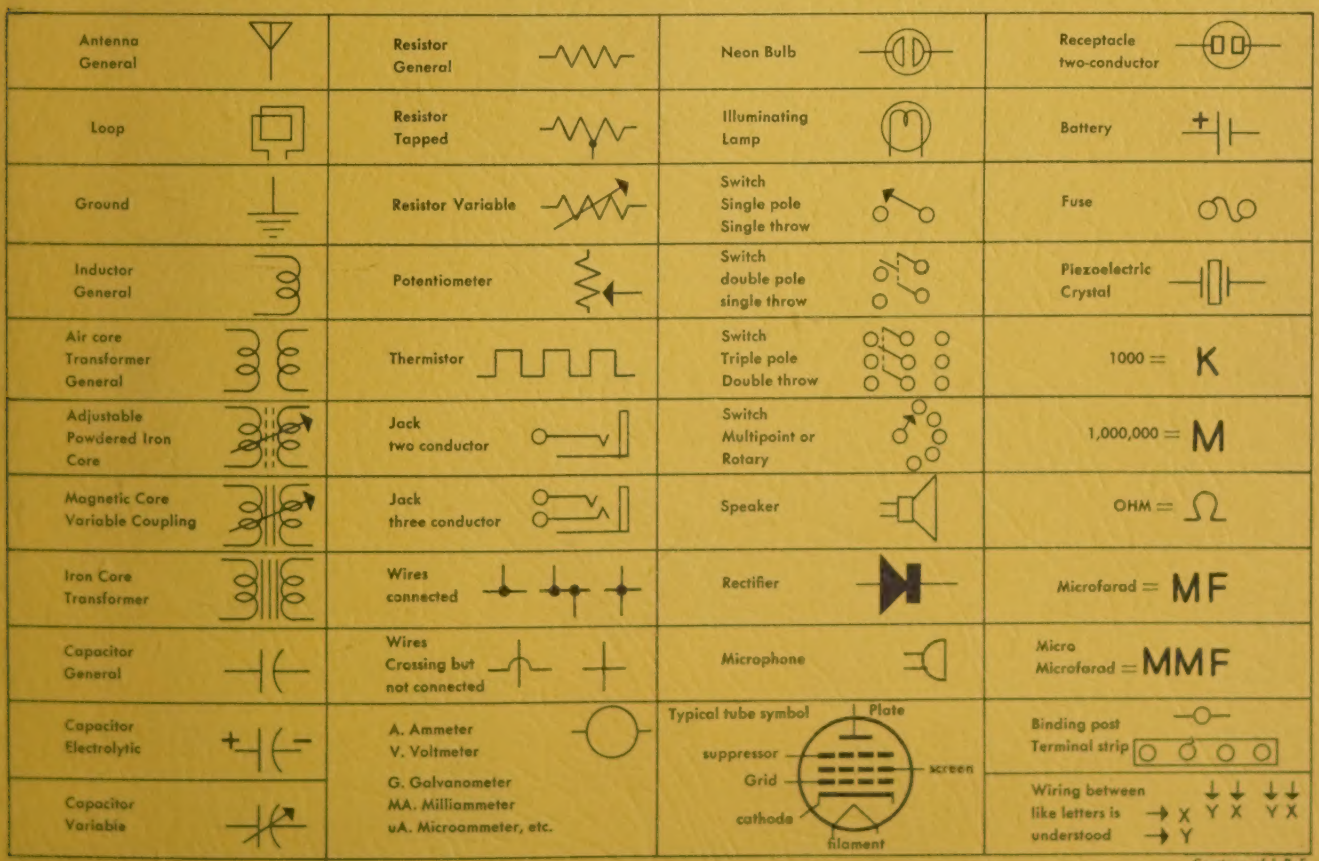
When removing insulation from the end of hookup wire, it is seldom necessary to expose more than a quarter inch of the wire. Excessive insulation removal may cause a short circuit condition in respect to nearby wiring or terminals. In some instances, transformer leads of solid copper will have a brown baked enamel coating. After the transformer leads have been trimmed to a suitable length, it is necessary to scrape the enamel coating in order to expose the bright copper wire before making a terminal or soldered connection.

In mounting parts such as resistors or condensers, trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use spaghetti or insulated sleeving over exposed wires that might short to nearby wiring.

It is urgently recommended that the wiring dress and parts layout as shown in the construction manual be faithfully followed. In every instance, the desirability of this arrangement was carefully determined through the construction of a series of laboratory models.

## SOLDERING

Much of the performance of the kit instrument, particularly in respect to accuracy and stability, depends upon the degree of workmanship used in making soldered connections. Proper soldered connections are not at all difficult to make but it would be advisable to observe a few precautions. First of all before a connection is to be soldered, the connection itself should be clean and mechanically strong. Do not depend on solder alone to hold a connection together. The tip of the soldering iron should be bright, clean and free of excess solder. Use enough heat to thoroughly flow the solder smoothly into the joint. Avoid excessive use of solder and do not allow a flux flooding condition to occur which could conceivably cause a leakage path between adjacent terminals on switch assemblies and tube sockets. This is particularly important in instruments such as the VTVM, oscilloscope and generator kits. Excessive heat will also burn or damage the insulating material used in the manufacture of switch assemblies. Be sure to use only good quality rosin core radio type solder.




Courtesy of I. R. E.

# HEATH COMPANY

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***THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM***

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